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Shipyard Rigging

BULLETIN 345-M

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF PUBLIC INSTRUCTION

HARRISBURG

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Vocational Training
for
War Production Workers

Installing a Propeller

SHIPYARD RIGGING

(A Manual of Instruction for Beginning and Advanced Training)

Bulletin 345-M

Prepared by the

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF INDUSTRIAL EDUCATION

In Cooperation With

SUN SHIPBUILDING AND DRY DOCK COMPANY
CHESTER, PENNSYLVANIA

SCHOOL DISTRICT, CITY OF CHESTER
CHESTER, PENNSYLVANIA

and

UNITED STATES OFFICE OF EDUCATION
FEDERAL SECURITY AGENCY

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Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
Harrisburg
1943

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Washington, D. C.

Foreword

The rapid expansion of shipbuilding has necessitated the training of additional ship iggers, and the upgrading instruction of persons who must accept additional respon- ibility in this field. It is in response to these training needs that this manual of instruc- ion has been prepared.

The various operations and processes presented have been developed through many ears of experience by men in the employ of the Sun Shipbuilding and Dry Dock Com- any. While some of the items presented are adapted to this particular shipyard it is elieved that most of the information given is standard practice which other shipyards vill find useful and adaptable to their training needs.

Acknowledgment is made to the Sun Shipbuilding and Dry Dock Company, Chester, 'ennsylvania, and to the foremen, riggers, and draftsmen employed by the Sun Yard or assistance and cooperation in supplying information, in criticizing methods, and in reparing instructional materials.

Special acknowledgment is extended to C. H. Bryson of the Riggers' Department, Sun Shipbuilding and Dry Dock Company, for his services as a technical adviser and for preparing a considerable part of the manual. This assistance, and that of Frank Klutterbuck and other men in the Riggers' Department, was invaluable.

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This manual of instruction was prepared at the Chester Field Curriculum Laboratory of the Pennsylvania Department of Public Instruction. Dean W. Conner, of the Pitts- burgh Public Schools, supervised the preparation of materials at the Laboratory. Charles Johnston, Adviser, Division of Industrial Education, assisted with the prepara- ion of the manuscript. The work was completed under the direction of Charles F. Zinn, Adviser, Division of Industrial Education, and under the general supervision of Paul L. Cressman, State Director of Vocational Training for War Production Workers.

FRANCIS B. HAAS
Superintendent of Public Instruction

April, 1943

Introduction

This manual may be used for training beginners in shipyard rigging, as well as for advanced instruction. Owing to the circumstances under which much rigging work is done, only certain types of job experiences can be duplicated in the training shop or classroom. However, considerable technical information can be taught which will materially aid the trainees in developing skill "on the job". Much of this information affects the safety of both workers and equipment.

In Part I, assignments have been provided for use in group or class instruction. Since these assignments do not include all types of work, it is suggested that supplementary work or assignments be provided where the instructor deems these to be necessary.

The time required to teach the materials included in this manual may vary considerably, depending upon the past experience, present employment, ability, and interest of the trainee. If the trainee is starting as a beginner with little shipyard experience, it is probable that four hundred hours will be required to present the instructional materials included in the manual. One keenly interested in advancement and having desirable opportunities to apply the instruction in his daily work may receive much essential instruction within eighty hours.

The manual provides reference materials for the use of employed workers. Information has been compiled from many sources. An endeavor has been made not to confine procedures and methods to those of one particular shipyard, with the result that the materials presented are sufficiently basic to be applicable to training for most shipyards.

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PART I

BEGINNING INSTRUCTION FOR SHIPYARD RIGGERS

[1]
RIGGERS' DEPARTMENT

The rigger's work begins when the ship is far enough advanced for the installation of any machinery.

Workers in this department secure heavy items of equipment weighing up to 50 tons or more to cranes for placing about the yard and lowering into the ship's hulls. The unwieldiness of different items, their odd shapes, and other factors make the tasks of the rigger extremely difficult. The different items must be balanced accurately and handled with considerable care because any slip might result in serious damage to the ship's hull, to the equipment being handled, or to the safety of the men.

Riggers frequently are divided into two groups, namely, machine riggers and loft riggers.

Machine Riggers

Machine riggers handle all machinery in and about the machine shops, transport it to and from the ships, and install it in proper locations on the ships. This machinery includes regular and spare propellers, tail shafts, thrust shafts, line shafts, crankshafts, bearings, rods, pistons, exhaust belts, gear cases, gears, rudders, rudderstock, steering gear, deck machines, capstans, windlasses; tanks for air, lubricating oil, and water; coolers, heaters, generators, dynamos, switchboards, panels, boilers, smokestacks, all engine and electric spares, and condensers.

Loft Riggers

Loft riggers install on ships the masts, cargo booms, cargo-handling gear; all standing and running rigging for these masts and cargo gear; all anchors and chains, tow and stream wires, lifeboats, life rafts, and all equipment for fire fighting, lifesaving, i.e., fire hoses, nozzles, reels, life rings, water lights, mooring lines, and radio antennae. The loft riggers also make all pendants, straps, and slings; do all wire and manila rope splicing; and maintain in good order all crane wires throughout the yard.

The more general work of riggers consists of work that either or both loft and machine riggers do, such as mooring, making fast, moving and

hauling ships from berth to berth, drydocking, launching, conducting trial trips; the moving, handling, or installing of special or delicate equipment; moving piping, sheet metal and copper piping from shop to ship as required by these departments.

SHIPYARD RIGGERS' JOBS

A Listing of Jobs and Fundamental Processes Performed by Shipyard Riggers

Signaling Cranes.

Handling Manila Ropes.

Tying Knots, Hitches, and Bends.

Splicing Manila Rope.

Attaching Sockets.

Attaching Clips or Clamps.

Using Thimbles, Hooks, Links, Rings, Shackles, and Turnbuckles.

Making and Using Slings and Pendants.

Using and Lashing Chain Hoists.

Installing Anchors and Anchor Chain.

Handling Different Kinds of Jacks.

Estimating Weights of Iron and Steel.

Operating Winches.

Placing Equipment in the Ship.

Moving Equipment in the Shop.

Stepping a Mast.

Placing a Smokestack on a Ship.

Handling Signal and Navigating Equipment.

Outfitting Lifeboats and Lifesaving Equipment.

Installing Fire-fighting Equipment on Board Ship.

Making, Installing, and Testing Standing and Running Rigging.

Testing Cargo-Lifting Gear.

Loading, Unloading, and Moving Heavy or Special Pieces of Electrica Mechanical, or Boiler Equipment.

Handling, Berthing, and Launching Ships.

Moving and Hauling Ships from Berth to Berth.

Mooring a Ship.

Laying a River, or Snubbing, Line.

Conducting Dock Trials.

Conducting Trial Trips.

Making Reports.

Reading Sketches and Blueprints.

Maintaining and Keeping an Adequate Supply of Crane Wire.

Splicing Wire Rope.

Keeping up and Maintaining an Adequate Supply of Wire Rope, Fixtures, Blocks and Falls, Chain Hoists, and all Necessary Equipment Used for Moving Heavy or Special Equipment.

Classification of Riggers at the Sun Shipbuilding and Dry Dock Company

Foreman Rigger

Quarterman

Assistant Foreman Rigger

Loftsman Rigger

First-class Rigger

Second-class Rigger

Third-class Rigger

Expediter

First-class Rigger's Helper

Second-class Rigger's Helper

Rigger Clerk

Duties of a Foreman Rigger

The foreman has general charge of all rigging procedures: the handling of all mechanical, pipe, boiler, sheet metal or copper, and electrical equipment in the shop; the handling of masts and smokestacks and the testing of cargo gear; handling anchor chain and signal and navigating equipment;

lifeboat, lifesaving, and fire-fighting equipment; installing and testing standing and running rigging; loading, unloading, and storage of any heavy or special pieces of electrical, mechanical, or boiler equipment.

In the various shops he also has charge of the removal or handling of any heavy or special equipment. The conduct of trial trips, the handling and berthing of a launched ship, and the wire ropes incidental to the launching of a ship are under his supervision.

He maintains and keeps an adequate supply of all crane wires throughout the yard. He supervises the moving and hauling of ships from berth to berth, and he is charged with the management, disciplining, and care of the men as workers for the Company.

A quarterman is a rigger having charge of fifty or more men.

A leaderman, or pusher, has general charge of five men who install pumps, boilers, main engine units, and auxiliaries, masts, cargo gear, beams, etc.

A first-class rigger signals cranes and works on jobs like handling pipe and small machinery where only two or three men are required; or, he may be assigned in a gang of five or six men on a job of heavy installation work.

A loft rigger's duties are similar to those of the machine rigger, except that he works above decks on masts, cargo-handling rigging, anchors, chains, lifeboats, rafts, and the like. Loft riggers are required to read sketches and blueprints.

An expediter is a man with some knowledge of rigging who makes advance checks of equipment used on new and repair boats and for general rigging work in order to make sure that the gear will be available when needed.

Requirements of a Second-class Rigger's Helper

He must be of employable age.

He must be physically fit.

He must be able to read, write, spell correctly, and possess sufficient intelligence to do the work required. If he shows signs of aptitude, he is promoted in about six months to a first-class rigger's helper.

Third-class Rigger

To be employed as a third-class rigger, one must have had two or three years of experience in shipyard work in structural steel erection, dredge

work, pile driving, shop machinery installation, or deck work on a ship. In addition to this employment experience, he must be thoroughly familiar with the following items of knowledge:

1. The materials of which straps, pendants, and slings are made.
2. The capacity of chain hoists used in rigging work.
3. The important knots used in rigging work and how to tie them.
4. Different kinds of splices.
5. Sizes of manila and wire ropes.
6. The reason for using a lashing ring when handling material.
7. The reason for mousing or seizing a hook on a load.
8. The difference between the hauling part and the standing part.
9. Safety precautions used if he is compelled to drop something from aloft to the ground or deck below.
10. The uses of the following:
    a. Blocks and falls
    b. A chain hoist
    c. A snatch block
    d. A heaving line
    e. Seizings and whippings
    f. A chain hook
    g. A backer
    h. A stopper
    i. A guy rope
    j. A topping lift

Handling Material

When workmen are moving large apparatus, methods of handling are of prime importance. Each piece of apparatus must be handled with reference to its special construction. Practically all of the handling of the larger machines and their parts is done by the riggers and the crane hook-on man, or the signal man. One should become familiar with the correct methods of handling such material.

There is a great difference between ropes and slings used for hoisting. The wear in ropes is indicated by frayed, loose, or cut strands. A chain, except for a few bruises, will not show any signs of weakness; although it may be full of small cracks which cannot be seen, or it may be crystallized to a great extent by long use.

Care should be used in every case to see that satisfactory slings and ropes are used to lift the load.

Any required removal of staging or beams should be arranged for in advance with the proper departments, i.e., stage builders, shipfitters, or erectors.

Surfaces to be cleaned should be cared for by the machinists.

Have the piece available for slinging under a crane where it can be lifted; also have adequate chain hoists and other gear ready, in order not to prolong holding the load.

The piece should be lashed and ready for slinging.

ASSIGNMENT

The Duties of a Rigger

OBJECTIVE

To learn what is expected of a rigger.

TOOLS AND MATERIALS

Paper

Pencil

PROCEDURE

1. Study the information given.
2. After the presentation of the duties of a third-class rigger in class, write the answers to the questions listed below.
3. When you have completed answering the questions, look up the correct answers in the information given and compare your answers with them.
4. Make a list of the questions that you failed to answer correctly. Give them further study.

QUESTIONS

1. When does the rigger's work begin?
2. Name the two groups of riggers.
3. What is a quarterman?
4. What is a leaderman?
5. What class rigger does crane signaling?
6. How long does a second-class rigger's helper who shows aptitude work before he is promoted?

[2]

GENERAL ARRANGEMENT OF A SHIP

In order to acquaint the riggers with the layout of tankers and cargo ships the most important locations, compartments, and spaces are shown and identified here.

Ship Terms and Locations

1. Ship's Anchor
2. Anchor Windlass
3. Chain Locker
4. Ammunition Trunk
5. Dry Cargo
6. Ammunition Chamber
7. Forepeak Tank
8. Deep Tank
9. Forward Pump Room
10. Forward Cofferdam
11. Walkway or Catwalk
12. Ship's Cargo Booms
13. Foremast
14. Navigating Bridge and Quarters for Officers
15. Lifeboats
16. Fresh-Water Tanks and Storage Place
17. King Post
18. Hose Boom (Booms for Lifting Hose to make Connections — For Loading Cargo)
19. Mainmast
20. No. 1 Cargo Tank
21. No. 2 Cargo Tank
22. No. 3 Cargo Tank
23. No. 4 Cargo Tank
24. No. 5 Cargo Tank
25. No. 6 Cargo Tank
26. No. 7 Cargo Tank
27. No. 8 Cargo Tank
28. No. 9 Cargo Tank
29. Ventilator and King Post
30. Smokestack
31. Lifeboats
32. Quarters for Officers
33. Quarters
34. After Cofferdam
35. Cargo Pump Room
36. Cargo Pump-Room Trunk
37. Fuel-Oil Tanks
38. Turbogenerator
39. Main Propulsion Motor
40. Boiler
41. Distilled-Water Tank
42. Propeller Shaft
43. Feed-Water Tanks or Double-Bottom Tanks
44. Feed-Water Tanks or Double-Bottom Tanks
45. Propeller
46. After-Peak Tank
47. Steering Gear
48. Fresh-Water Tank
49. Rudder
50. Bosun's Stores
51. Chain Locker
52. Deep Tank and Dry Cargo Space
53. Forward Pump Room
54. Cargo Tank No. 1 Port

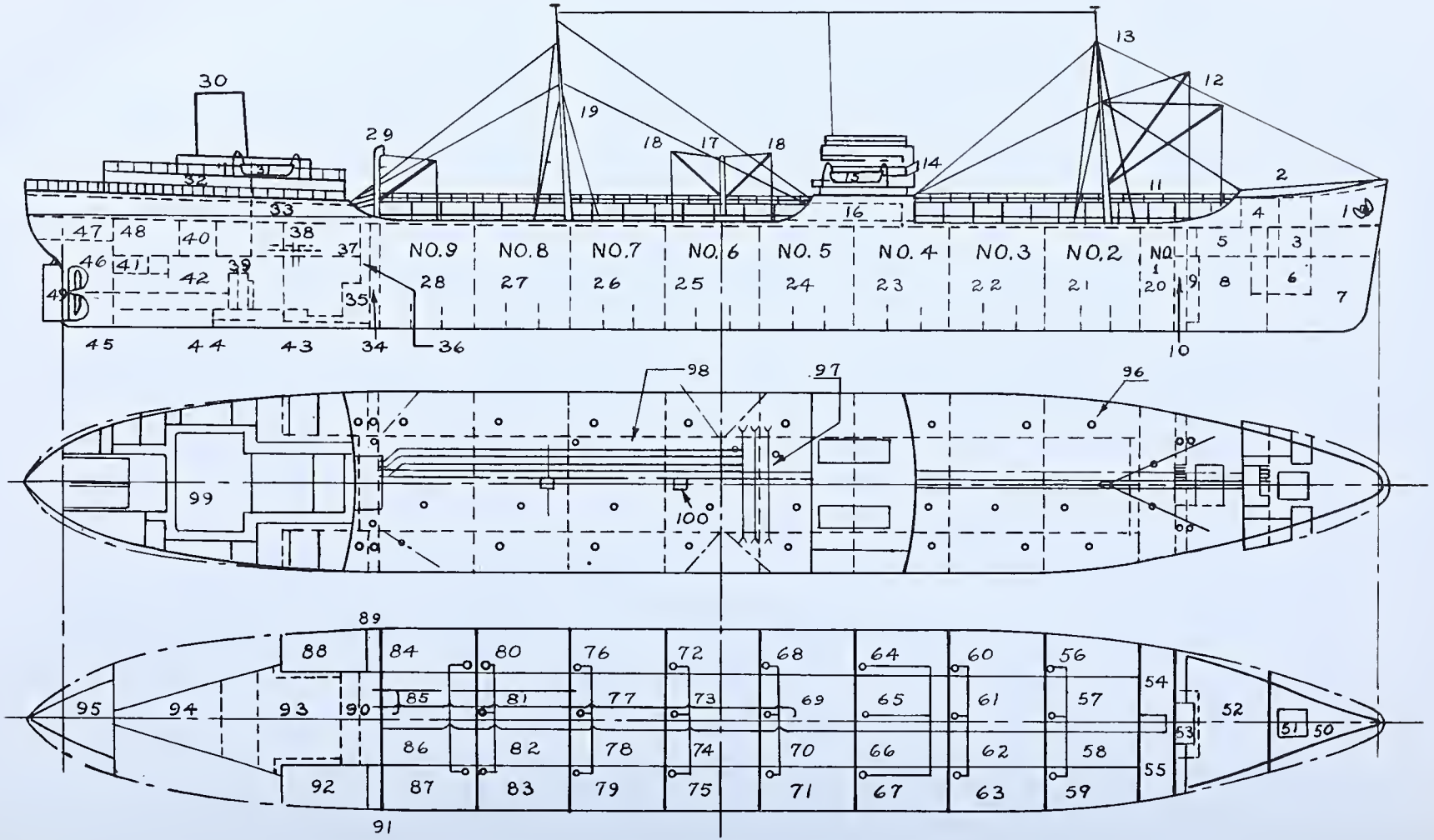


FIG. 1 — *General Arrangement of a Tanker*

55. Cargo Tank No. 1 Starboard
56. Cargo Tank No. 2 Port Wing Tank
57. Cargo Tank No. 2 Center Port
58. Cargo Tank No. 2 Starboard Center
59. Cargo Tank No. 2 Starboard Wing Tank
60. Cargo Tank No. 3 Port Wing Tank
61. Cargo Tank No. 3 Center Port
62. Cargo Tank No. 3 Center Starboard
63. Cargo Tank No. 3 Starboard Wing Tank
64. Cargo Tank No. 4 Port Wing Tank
65. Cargo Tank No. 4 Center Port
66. Cargo Tank No. 4 Center Starboard
67. Cargo Tank No. 4 Starboard Wing Tank
68. Cargo Tank No. 5 Port Wing Tank
69. Cargo Tank No. 5 Center Port
70. Cargo Tank No. 5 Center Starboard
71. Cargo Tank No. 5 Starboard Wing Tank
72. Cargo Tank No. 6 Port Wing Tank
73. Cargo Tank No. 6 Center Port
74. Cargo Tank No. 6 Center Starboard
75. Cargo Tank No. 6 Starboard Wing Tank
76. Cargo Tank No. 7 Port Wing Tank
77. Cargo Tank No. 7 Center Port
78. Cargo Tank No. 7 Center Starboard
79. Cargo Tank No. 7 Starboard Wing Tank
80. Cargo Tank No. 8 Port Wing Tank
81. Cargo Tank No. 8 Center Port
82. Cargo Tank No. 8 Center Starboard
83. Cargo Tank No. 8 Starboard Wing Tank
84. Cargo Tank No. 9 Port Wing Tank
85. Cargo Tank No. 9 Center Port
86. Cargo Tank No. 9 Center Starboard
87. Cargo Tank No. 9 Starboard Wing Tank
88. Fuel-Oil Tank
89. Cofferdam
90. Cargo Pump Room
91. Cofferdam
92. Fuel-Oil Tank
93. Engine Room
94. Shaft Alley and Machinery Space
95. After-Peak Tank
96. Cargo Hatch Covers
97. Heating Coils
98. Heating Coil Piping on Keel Plate
99. Boiler Room
100. Deck Winch.

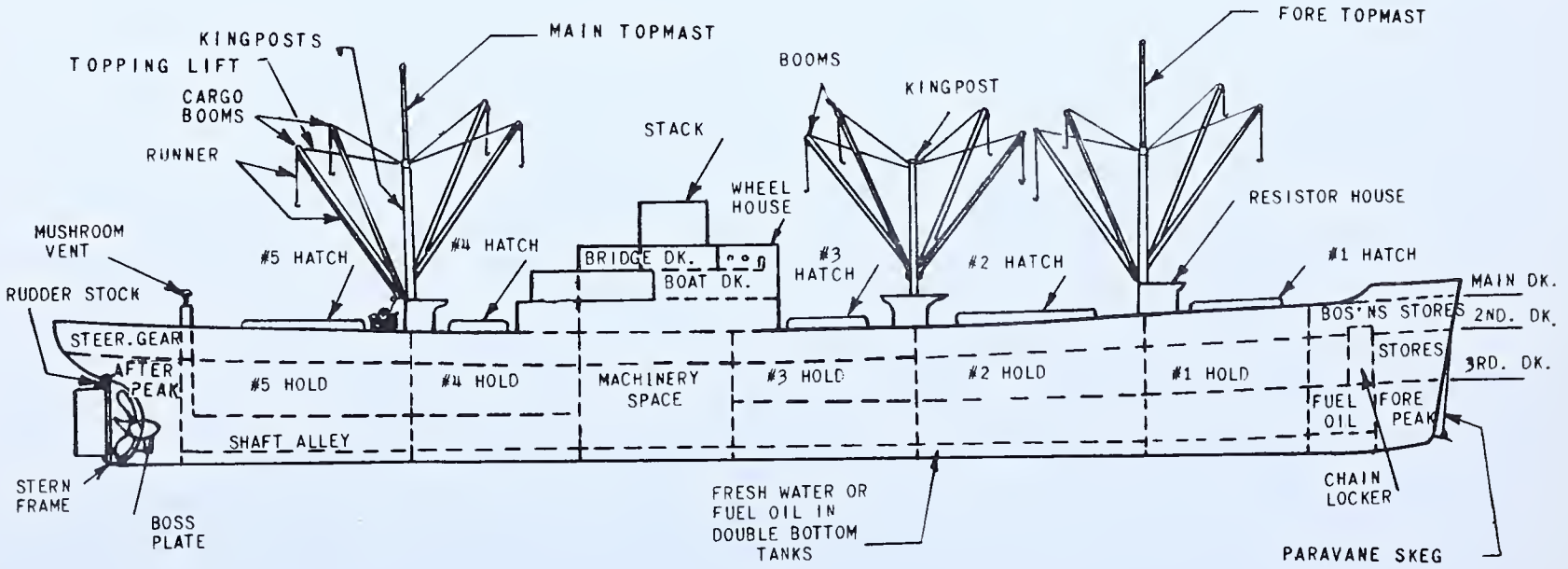


FIG. 2 — *Profile of a Cargo Ship*

Figure 2 shows the profile of a cargo ship, which, when compared to the tanker, differs considerably. The double bottom extends from the after-peak bulkhead to the forepeak bulkhead. This space, which is under the tank top, is used for fresh water or fuel oil, or both.

In the cargo ship shown, the machinery space is located amidship, so that when the ship is traveling light, balance can be maintained in the fore-and-aft trim of the ship. The machinery space on a tanker is not located amidship because this would necessitate the use of a shaft alley through the oil-carrying cargo tanks. On the cargo ship the shaft alley does extend from the engine room through No. 4 and No. 5 holds to the stern frame and propeller.

Most cargo ships have but five cargo holds, each separated from adjoining holds by watertight bulkheads. These holds are not separated or divided by any longitudinal bulkheads, although they are separated by different decks, as shown in Fig. 2, the second deck just below the main deck and the third deck below the second. All of these decks are reached through the one hatch at the main deck and are used to separate and keep apart different types of cargo.

On the cargo ship the cabins, or quarters, are usually confined to the midship houses, as shown in Fig. 2.

ASSIGNMENTS

Locating the Units of a Ship

Objective

To become acquainted with the parts of a ship that a rigger must know.

Tools and Materials

Paper

Pencil

Ruler

Procedure for a Tanker

1. Make a rough sketch of the profile of a tanker.

2. On the sketch place numbers in circles to denote the following parts of the ship:

1. Bow
2. Midship house
3. Stern
4. After house
5. Forward hold
6. Pump room
7. Engine room
8. Boiler room
9. Steering engine room
10. Cargo holds or tanks
11. Foredeck by foremast
12. After deck by mainmast

PROCEDURE FOR A CARGO SHIP

1. Make a rough sketch of the profile of a cargo ship.
2. On the sketch place numbers in circles to denote the following parts of the ship:

1. Resistor house
2. No. 5 hatch
3. Foremast
4. Mainmast
5. King posts
6. Machinery space
7. Shaft alley
8. Chain locker
9. Rudderstock
10. Cargo booms
11. Bosun's storeroom
12. Topping lift of cargo booms

QUESTIONS

1. **Cargo tanks are numbered 1 to 9. Is No. 1 cargo tank forward or aft?**
2. **State the location of the cargo pump room.**
3. **Where are the fuel oil tanks located?**
4. **Is the main propulsion motor nearer to the bow or the stern of a tanker?**
5. **What is the purpose of the propeller shaft?**
6. **When facing the stern of a ship, is the port side on the right or on the left?**
7. **Explain the reason for the steering gear, and give the location.**
8. **Where is the deep tank? The dry cargo tank?**
9. **Cargo tanks have port wing, center, and starboard wing divisions. Are these divisions separated from each other?**
10. **In the engine room, what jobs will be done by the riggers?**
11. **Give the location of the engine room.**
12. **Where is the generator flat located?**
13. **Where are the cargo pump valves located?**
14. **What is meant by the cargo pump-room trunk?**
15. **Where is the machinery space on a cargo ship?**
16. **Where is the shaft alley on a cargo ship?**
17. **Locate No. 1 and No. 3 Cargo Holds on a cargo ship.**
18. **What is a resistor house?**

[3]
SAFE PRACTICES FOR RIGGERS

Safety is a vital factor in the conduct of any shipbuilding industry; safe practices should be enforced by the yard and very carefully observed by the men. Both parties are equally concerned. Any injury resulting in loss of time is alike disastrous to employer and employee. Protect your ability to earn a livelihood by being safety-conscious at all times. You may protect others as well as yourself through intelligent observation of safe practices. Unsafe practices in a shipyard usually endanger others. Be careful for your fellow workmen as well as for yourself.

Typical Shipyard Hazards

DANGER OF FALLING

Unsafe footing.

Presence of objects which would make footing hazardous, such as scrap or oil.

Insecure staging, spawls, or other working supports.

Improper treatment of guardrails; improper use of tools.

Improper shoes.

Hose, burning and welding lines, electric feed wires.

Failure to replace staging which has been moved.

DANGER FROM FALLING OBJECTS

*Exceeding safe working loads for equipment which may result in breakage.

Insecure fastening of loads.

Poorly applied or unsafe lifting pads.

Leaving loose objects where they may slide off the vessel or staging.

Danger of dropping tools while using them.

*NOTE — Safety factors are explained completely in Instruction Sheet No. 10 — "Kinds of Wire Rope".

Danger of dislocating planks, small parts of equipment, or other object in swinging a load with a crane.

Carelessly throwing scrap from the ship.

Improper shoring.

Working under loads being lifted or erected.

Danger From Inadequate Personal Protection

Loose clothing, especially pant legs.

Lack of safety shoes.

Lack of safety helmets.

Lack of goggles where necessary.

Lack of proper eye shields around welding.

Taking foolhardy risks.

Improper use of tools and equipment.

Daydreaming.

Use of Proper Equipment

Make sure the hoist is hung to a solid member of sufficient strength t hold the load which it is to carry.

See that the lashing, choker, pendant, sling, shackle, or clamp used is o sufficient strength to hold the load.

Use a chain hoist of correct capacity.

Particular attention should be given to the use of chafing gear, bagging or wood softeners. If the wire or manila rope of pendants or slings come in contact with sharp steel edges, it will cut and break.

Wire cable slings are generally used in hoisting. Care should be take to see that one rope of a sling or pendant does not ride over the other rop as this will put an undue strain or load on the outer rope or cable.

Spreaders are used to keep the slings or pendants from chafing th machine or piece of equipment that is being lifted.

ASSIGNMENT

Safety Practices for Riggers

OBJECTIVE

To become safety-conscious.

TOOLS AND MATERIALS

Paper

Pencil

PROCEDURE

1. Study the information.
2. Write the answers to the questions listed below.
3. Check your answers with the information given, and make a list of those questions you failed to answer correctly. Give them further study.
4. Write again the answers to those that you missed.

QUESTIONS

1. **Why is safety a vital factor around a shipyard?**
2. **What important kinds of safety must a rigger know and practice?**
3. **What are the proper kinds of shoes for the rigger to wear while working in a shipyard?**
4. **Why should one keep clear of a load that is being lifted by a crane?**
5. **What is meant by a safe load?**
6. **Why are safety helmets worn by the workers?**
7. **What is meant by the expression, "using a chain hoist of proper capacity"?**

[4]
CRANE SIGNALS

Crane Signals Used at the Sun Shipyard Are Illustrated in Fig. 3

Explanation of Signals

1. Hoist (Raise the load) — Point upward, wave the forefinger in a circle.
2. Lower (Lower the load) — Up-and-down flapping motion of the wrist with palm of hand downward.
3. Hoist Slowly — With the forefinger draw a circle in the palm of left hand.
4. Stop — Move the outstretched hand back and forth slowly.
5. Emergency Stop — A vigorous sweeping motion of the hand and arm back and forth at about waist level.
6. Down the Pier or Down the Track (Crane to travel away from signaler) — Wave the hand in a "go away" motion.
7. Up the Pier or Up the Track (Crane to travel toward the signaler) — Wave the hand in a "come to me" motion.
8. Boom Up (Elevate the boom of the crane) — Upward jerking motion of the thumb.
9. Boom Down (Lower the boom to the right) — Downward jerking motion of the thumb.
10. Right Boom (Move the boom to the right) — Point with finger to right-hand side.
11. Left Boom (Move the boom to the left) — Point with finger to left-hand side.

Signals for Designating Hoist to be Used

12. Raise one finger for small hoist.
13. Raise two fingers for large hoist.

Location on Ship of Loads Being Sent Up

14. Midship — Place hand on stomach, meaning center of ship.
15. Top deck — Hold hand on top of head.
16. Number of Cargo Hold — 1 finger for No. 1; 2 fingers for No. 2 3 fingers for No. 3, and so on to numbers of whatever cargo hold is used
17. Engine Room — Use both hands in revolving motion similar to crank shaft of an engine.
18. Pump Room — An up-and-down pumping motion of the hand at th side tells the crane operator to put the load in or near the pump room
19. Emergency — The arms crossed with the hands at shoulders is th emergency signal to bring a stretcher or a basket for an injured man

Use Proper Signals

The signal man should be careful to give the proper signals at all time and see that his signal is clear. A misunderstood signal may lead to controversy with the crane operator when the fault may be that of the ma giving the signal. While signaling, look sometimes at your signal han yourself and see if you are giving the signal properly. On foggy, cloud days, or when the signal man is working where smoke is rising out of hold, the crane operator may have difficulty in seeing a signalman's hand It is advisable, under these conditions, to remove gloves before signaling

Signals for Night Workers

While working at night, the operator cannot always see the signalman therefore night signals are often given by whistle, or by flashlight. Th whistle signals are:

1 blast — Stop (At any time).

2 blasts — Hoist (Raise the load).

3 blasts — Lower the load.

4 blasts — Move aft.

5 blasts — Move forward.

1 short and 1 long blast — Move to port.

1 short and 2 long blasts — Move to starboard.

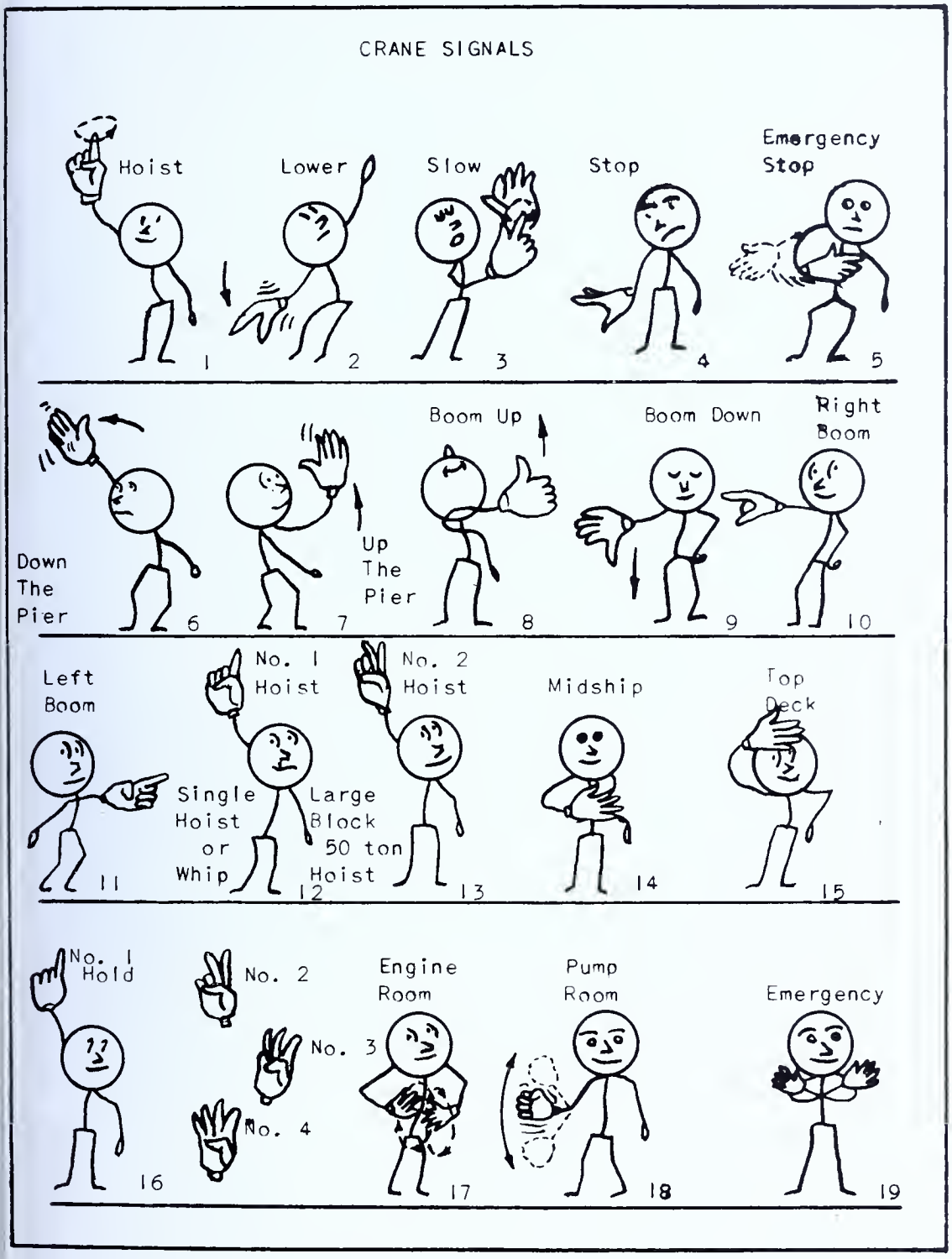

CRANE SIGNALS
Hoist
Lower
Slow
Stop
Emergency Stop
1
2
3
4
5
Down The Pier
Up The Pier
Boom Up
Boom Down
Right Boom
6
7
8
9
10
Left Boom
No. 1 Hoist
No. 2 Hoist
Midship
Top Deck
Single Hoist or Whip
Large Block 50 ton Hoist
11
12
13
14
15
No. 1 Hold
No. 2
No. 3
No. 4
Engine Room
Pump Room
Emergency
16
17
18
19

FIG. 3

When working by whistle blasts, always remember that there are many noises in a shipyard. The operator may not always hear the whistle, and at times other noises may confuse him. The use of a whistle in signaling is not recommended because the chance of making a mistake is too great.

Flashlight Signals

Flashlight signals are used for night work, since they are more reliable and are more easily seen and recognized than whistle signals. The light is turned on, pointed upward, and waved in a circular motion for "Hoist"; it is waved up and down in a vertical swing for "Lower"; and it is swung back and forth in a horizontal plane for "Stop." Light signals sometimes are given by blinking the light. When signaling with a blinking light, the signalman flashes the light the same number of times as blasts of the whistle: one blink to stop, two to go up, three to lower, four to move after, five to move forward, one short and one long to move to port, and one short and two long to move to starboard.

Relaying Signals

When the signalman is working in a lower position over the opposite side of the ship or in any cargo tank or engine room, it may be necessary for him to relay signals. A signal relayed from the man on the job to the signalman at the top of the ship and then to the crane operator may not receive an immediate response. When relaying signals, take into consideration the time necessary for relaying so that the crane will not hoist beyond the desired position. In some such cases it would be possible to break the hoisting equipment and perhaps drop the load. Lifting anything which connects on the under side to another object is dangerous. The "Stop" signal should be given before the object has reached the point where you want it to stop. Should the object stop before it has reached the proper place, a slight additional "slowly hoist" signal would complete the operation without causing an accident. DO NOT TAKE CHANCES. LEARN TO GIVE YOUR SIGNALS CORRECTLY.

ASSIGNMENT

Crane Signals

OBJECTIVE

To become familiar with the various crane signals.

TOOLS AND MATERIALS

Paper

Pencil

PROCEDURE

1. Listen carefully to the instructor's explanation of the various crane signals.
2. As the signals are given by the instructor write them in the order given.
3. Be able to give the various signals while the others in the class write what each means.
4. Check with the information given to see which signals you have missed. Give them further study.

QUESTIONS

1. **Why are crane signals necessary?**
2. **What kinds of signals are used for night work?**
3. **How are signals relayed, and why is it necessary to have them relayed?**
4. **Why should gloves be removed when making crane signals?**

[5]
TOOLS AND MATERIALS

A Frames
Blocks and Falls
Cables
Carew Cutters
Chains
Chain Hoists (Falls)
Chain Rope Stoppers
Chokers
Clamps, Beam
Clamps, Polly
Clips
Corner Machine
Cranes
Cutting Torch
Cutters, Hydraulic Wire
Dolly, Shaft
Eyebolts
Equalizing Bar
Extension Bar
Fids
Flashlights
Furnace for Melting Zinc
Gantlines
Gauges
Gin Blocks
Gin Poles
Grommets
Hauling Wires
Hooks
Jacks
Jackknives
Ladles
Lashings
Lashing Rings
Links, Detachable
Marline Spikes
Mooring Swivels
Mooring Wires
Needles
Nippers
Palms
Pendants
Pier Winches
Rafts
Rake Templates
Rigging Screws
Rollers
Ropes, Manila and Wire
Rudder Pads
Safety Belt
Seizing Wire
Serving Boards
Serving Mallets
Shackles
Ship Blocks
Slings
Snatch Blocks
Sockets
Splashboard or Plate
Splicer's Vise
Spreaders
Staging — Dry Dock
Tapeline (100-foot)
Thimbles
Trestles
Turnbuckles
Twine
Wedges
Whistles
Winches
Wire Cutters
Wrench
Yarn

ms and Definitions for Shipyard Riggers in the back of this book explain the
f the various tools and equipment listed above.

ASSIGNMENT

Tools and Materials

OBJECTIVE

To learn to recognize the various tools and pieces of equipment used by riggers.

PROCEDURE

1. Study the list of tools and equipment.
2. Examine the list of "Terms and Definitions" in the back of the book.
3. Be prepared to identify certain tools and pieces of equipment that may be exhibited in the school or discovered during exploratory trips to the yard or rigging loft.
4. Don't hesitate to ask questions.

[6]
ROPES (VEGETABLE FIBER)

Rope is one of the rigger's most valuable tools for moving ships and lifting weights.

There are two kinds of rope commonly used by riggers. They are vegetable-fiber rope and wire rope. Manila rope is made from the fiber of the wild banana plant, while wire rope is made of iron and various grades of steel, some of which are galvanized for protection against rust.

Manila rope is made up of yarn or threads which are fibers twisted together. Three or more yarns twisted together make up a strand. The strands are twisted in the opposite direction to the twist in the yarns. Another fiber rope is sisal, but it has less strength than Manila fiber ropes.

FIG. 4 — *Plain-laid Rope*

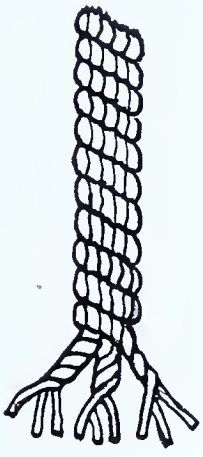


FIG. 5 — *Cable-laid Rope*

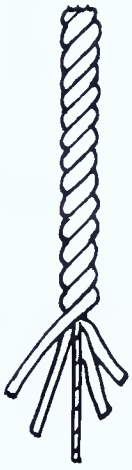


FIG. 6 — *Plain-laid Rope With a Heart*

Figure 4 shows a piece of plain-laid rope which is made up of three strands twisted together. Some plain-laid ropes consist of four or six strands.

Figure 5 shows a piece of cable-laid rope which is merely three or four plain-laid, three-stranded ropes twisted together in the opposite direction to the twists of the plain-laid ropes.

A cord consists of several strands twisted together.

Rope twisted to the right is known as right-lay rope and if twisted to the left it is known as left-lay rope.

A rope five inches or more in circumference is called a hawser.

Some rope is made with a heart or rope in the center as shown in Fig. 6.

Rope is put up in coils of 1,200 feet or in half coils.

Small lines or "small stuff" as it is called is used for seizing, worming, whipping, lashing, and mousing. Some of the different kinds of small stuff are:

1. Houseline which is a small line of three strands laid left-handed. It is used for seizing, or mousing, as it is sometimes called.
2. Roundline is a three-stranded, right-handed line. It is used for worming large ropes.
3. Hambroline is similar to roundline except that the twist is in the opposite direction.
4. Marline is a small line of two strands twisted loosely left-handed. It is used quite extensively for covering wire rope to protect the hands of workman. It is known as marline-clad wire rope.
5. Spun yarn is two or more rope yarns loosely twisted.

How to Open a Coil of Manila Rope

PROCEDURE:

1. Loosen the cover.
2. Lay the coil on the flat side with the inside end at the bottom.
3. Reach through the center of the coil, and pull the rope up through the center. Never uncoil the rope from the outside, as it is apt to put kinks in it.

How to Thoroughfoot a Rope

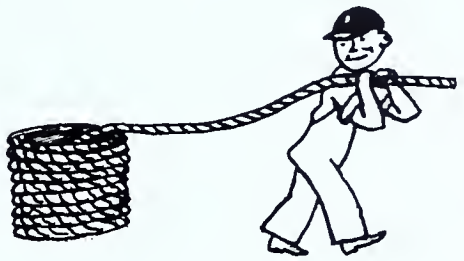
PROCEDURE:

1. Coil down against the lay.
2. Bring the lower end up through the center of the coil.
3. Coil down with the lay.

Rope that has many turns should be coiled small, and if there are only a few turns it should be coiled large.

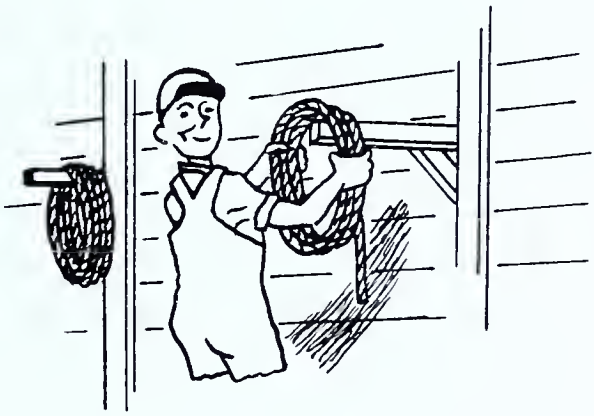
The Use and Care of Manila Rope*

Start it Right



When removing the usual right-laid rope from the coil, make sure that it unwinds in a counter-clockwise direction.

Store it Properly



A dry, unheated building or a room with a free-air circulation is the best place to store rope when not in use. Place rope in loose coils off the floor on wooden grating or hang on a wooden peg. If rope is dirty, wash thoroughly in clean water and dry before storing. Rope should never be stored in a small confined space without air circulation. Improper storage conditions are a common cause of the so-called dry rot.

Kinks Are Avoidable

If the use of rope involves continual twisting in one direction, compensating turns must be thrown in or out to avoid damage to the rope's structure. Kinks pulled through restricted space, such as in a tackle block, will shear the fibers and weaken the rope.

*This information was furnished by the Plymouth Cordage Company.

Beware of Chemicals

Many chemicals are very injurious to rope fibers and will cause severe rope damage. Rope should not be stored in close proximity to chemicals, especially acids or alkalis, or where contact with chemicals or fumes may result. Common causes of rope injury are acids used in storage batteries and in washing the sides of buildings. Special care should be taken to prevent the contamination of rope by these acids to insure long rope service and safety. Drying oils, such as linseed oil, will damage rope. Rope life will be increased if rope is kept free from paint.

Knots are Only Half as Strong as Splices

Splices are much better and stronger than knots for permanent connections, since the best knot reduces the strength of a rope approximately 50%.

The "Short" Splice is the strongest method of joining ropes, but it should not be used on pulley work as the rope is nearly doubled in size and exposes the strands to extra chafing.

The "Long" Splice is adapted for pulley work and is nearly as strong as the "Short splice.

Know Your Loads

Overloading your rope is costly, and it is dangerous to men and materials. The safety factor of a rope is the ratio between the minimum breaking strength and the load applied. A safety factor of 5 is recommended under ordinary circumstances. Due allowance for the condition of the rope should be made when determining the proper factor of safety.

Play Safe! Be Thrifty!

Reverse ropes, end for end, periodically, as in tackle use, so that all sections of the rope will receive equal wear.

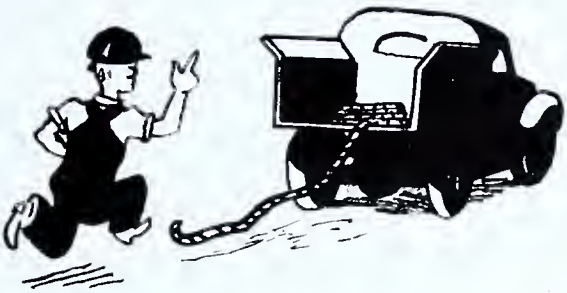
When rope wear is localized in a short section, periodical shortening presents a new wearing surface.

Should a rope become damaged, cut it and splice it. A good splice is safer than a damaged section.

Reduce Wear and Abrasion

Surface wear may come from allowing one rope to chafe another, or by dragging it over sharp or rough objects which cut or break the outer fibers.

Dragging a rope over the ground will pick up sand, grit, or other abrasive particles which work into the rope, cut it, and cause abrasion of the inner fibers.



Maximum rope stress, as well as increased wear and friction load, is produced by small sheaves. False economy leads to the use of blocks and sheaves too small for the diameter of the rope.

A sharp bend reduces the tensile strength of rope by putting extra strain on the outer fibers.

Do not attempt to add lubrication to the rope. Lubrication built into Manila rope is adequate for its entire life.

Under conditions where a rope must necessarily run over some surface such as cleats, winch heads, etc., be sure that the surface is smooth.

Testing Manila Rope

In order to test the tensile strength of various makes of Manila rope, tests are made with the hydraulic testing machine. Pendants about three feet long with an eye splice in each end were put on the testing machine with the following results.

6-thread Manila rope broke at 750 pounds.
9-thread Manila rope broke at 1200 pounds.
15-thread Manila rope broke at 2300 pounds.
18-thread Manila rope broke at 2300 pounds.
21-thread Manila rope broke at 3150 pounds.

2-inch-circumference Manila rope broke at 4800 pounds.
2 ½-inch-circumference Manila rope broke at 7500 pounds.
3-inch-circumference Manila rope broke at 10,000 pounds.
4-inch-circumference Manila rope broke at 18,050 pounds.

In Table I the safe loads for Manila rope slings are as follows:

2-inch-circumference Manila rope is 880 pounds.
3-inch-circumference Manila rope is 1800 pounds.

Safe loads for Manila rope tested would be as follows:

2-inch-circumference Manila rope would be 4800 lbs. ÷ 5 or 960 lbs.
3-inch-circumference Manila rope would be 10,000 lbs. ÷ 5 or 2,000 lbs.

When a rope that is in first-class condition breaks under a load, there must be some reason for its breaking. The safe load on a piece of rope will depend on what the rope is used for; therefore in a table of safe loads a safety factor must be used that will cover all uses to which the rope may be put.

With the ropes tested a safety factor of 5 was used, meaning that the safe load is 1/5 of the breaking strength.

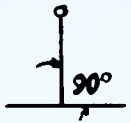
In some instances a safety factor as high as 8 to 1 is used, depending upon the use to be made of the rope and the working conditions. Unfavorable working conditions, such as sharp edges, close nips, knots, etc., increase the safety factor.

Table I

SAFE LOADS IN POUNDS FOR MANILA ROPE SLINGS

(Loads specified must not be exceeded)

Manila Rope — A Safety Factor of 5 Was Used in This Table

SIZES		WEIGHTS		Number of Feet in 1 lb.	Breaking Strengths in Pounds	SAFE WORKING LOADS IN POUNDS			
						Used Straight	Used at 60° Angle	Used at 45° Angle	Used at 30° Angle
Circum-ference	Diameter	Full Coils 1200 feet	Pounds Per 100 ft.						
5/8	3/16	17	1.43	70.	450	90	65	60	45
3/4	1/4	21	1.72	58.	550	110	80	70	55
1	5/16	31	2.63	38.	950	190	140	125	95
1 1/8	3/8	45	3.71	27.	1,300	260	195	170	130
1 1/4	7/16	64	5.26	19.	1,750	350	260	230	175
1 1/2	1/2	90	7.5	13.3	2,650	530	390	350	265
1 3/4	9/16	125	10.4	9.6	3,450	690	515	460	345
2	5/8	160	13.3	7.5	4,400	880	660	585	440
2 1/4	3/4	200	16.7	6.0	5,400	1,080	810	720	540
2 1/2	13/16	234	19.5	5.13	6,500	1,300	975	865	650
2 3/4	7/8	270	22.5	4.45	7,700	1,540	1,155	1,025	770
3	1	324	27.0	3.71	9,000	1,800	1,350	1,200	900
3 1/4	1 1/16	375	31.3	3.20	10,500	2,100	1,575	1,400	1,050
3 1/2	1 1/8	432	36.0	2.78	12,000	2,400	1,800	1,600	1,200
3 3/4	1 1/4	502	41.8	2.40	13,500	2,700	2,025	1,800	1,350
4	1 5/16	576	48.0	2.09	15,000	3,000	2,250	2,000	1,500
4 1/2	1 1/2	720	60.0	1.67	18,500	3,700	2,775	2,465	1,850
5	1 5/8	893	74.4	1.34	22,500	4,500	3,375	3,000	2,250
5 1/2	1 3/4	1,073	89.5	1.12	26,500	5,300	3,975	3,530	2,650
6	2	1,290	108.0	.930	31,000	6,200	4,650	4,130	3,100
6 1/2	2 1/8	1,503	125.0	.800	36,000	7,200	5,400	4,800	3,600
7	2 1/4	1,752	146.0	.685	41,000	8,200	6,150	5,465	4,100
7 1/2	2 1/2	2,004	167.0	.600	46,500	9,300	6,975	6,200	4,650
8	2 5/8	2,290	191.0	.524	52,000	10,400	7,800	6,930	5,200
8 1/2	2 7/8	2,580	215.0	.465	58,000	11,600	8,700	7,730	5,800
9	3	2,900	242.0	.414	64,000	12,800	9,600	8,530	6,400
9 1/2	3 1/8	3,225	269.0	.372	71,000	14,200	10,650	9,465	7,100
10	3 1/4	3,590	299.0	.335	77,000	15,400	11,550	10,265	7,700
Approximate fractional part of "Used Straight" Column →							3/4	2/3	1/2

Four-strand has approximately the same tensile strength as three-strand and runs 5 to 7% heavier.

Tarred Manila is approximately 25% heavier than Manila and has the same strength.

Manila rope is put up in full coils of 1,200 feet and in smaller or half coils of 600 feet.

Safe loads specified in the above table are for each single Manila rope. When used double, or in any other multiple, the load may be increased proportionately. For example, if the sling has 3 legs, the load may be increased three times the load specified above. Stub hooks may be used with lifting apparatus provided with holes for that purpose.

ASSIGNMENTS

Manila Rope

OBJECTIVE

To learn the lay of rope.

TOOLS AND MATERIALS

Several pieces of Manila rope (labeled):

1. Plain-laid
2. Cable-laid
3. Four-stranded, plain-laid with heart

PROCEDURE

1. Examine the three pieces of rope carefully.
2. Take them apart, and observe how each is constructed.
3. Now examine the piece of left-laid rope, and notice how it differs from a right-laid rope.
4. Write the answers to the following questions.

QUESTIONS

1. **What are the two classifications of ropes according to their composition?**
2. **Which is stronger, Manila or sisal rope?**
3. **What is yarn?**
4. **What is a strand?**
5. **What keeps Manila rope from untwisting?**
6. **What is a plain-laid rope?**
7. **How can one tell the difference between right-lay rope and left-lay rope?**
8. **What is a hawser?**
9. **What is marline, and what are its chief uses?**
10. **How does houseline differ from marline?**
11. **What is roundline?**
12. **How does hambroline differ from roundline?**
13. **What is the advantage of using spun yarn when serving a rope?**

Opening a Coil and Thoroughfooting a Rope

OBJECTIVE

To learn how to coil and thoroughfoot a rope.

TOOLS AND MATERIALS

A coil of rope

PROCEDURE

1. Loosen the burlap cover.
2. Lay the coil on the flat side with the inside end down.
3. Reach down through the center of the coil, and draw the rope up and out of the coil. (Do not uncoil from the outside because kinks are apt to form.)
4. Thoroughfoot the rope after it has been uncoiled.
5. Coil it down against the lay.
6. Bring the lower end up through the center of the coil, and coil it down with the lay.
7. If there are many turns to be made in the rope, coil small; if few turns, coil large.
8. Now wrap up the coil the same as it was at first.

QUESTIONS

1. **Why not uncoil a rope from the outside?**
2. **What is meant by thoroughfooting a rope?**
3. **Why should taut, dry ropes be slackened off when wet by rain?**
4. **Where should rope be stored?**
5. **What should be done with boatfall ropes when they are no longer in serviceable condition?**
6. **Why should rope be dry before it is stored?**
7. **How should ropes be cleaned?**
8. **What is meant by a safe load?**

[7]
KNOTS, HITCHES, AND BENDS*

General Information

A knot is a knob formed in a piece of rope by interweaving its strands or ends.

A hitch is a temporary knot or noose by which a rope is fastened to another rope, a spar, or a post so as to be readily untied.

A bend is a method of fastening one rope to another or to a ring, loop, etc. by passing the rope through a loop and fastening it back around itself, as a sheet bend.

How to Whip a Rope

The ends of a rope, or the ends of each strand if the strands are separated, should always be "whipped," or bound, to prevent raveling and loss of turn in the rope.

A fine yarn, marline, or spun yarn is generally used.

Procedure

1. Place the end of the yarn in the contline of the rope with the end of the yarn pointing towards the end of the rope to be whipped and make one or two turns around the rope to hold it in place. See Figure 7.

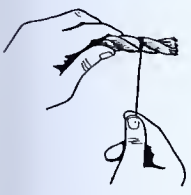


Fig. 7

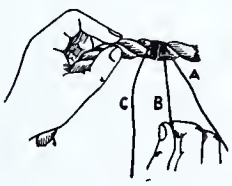


Fig. 8

Fig. 9 — *A Whipping*

*The source of material for this information was furnished by the Plymouth Cordage Company.

2. Lay the main part of the yarn lengthwise along the rope, forming a long loop, one part of which, B, is held tight. This is wound around both the rope and the yarn until a sufficient number of turns have been made. See Fig. 8.

3. Pull the end C until the loop is tight under the whipping. Then cut off close to the rope.

To make a whipping in this manner, it is not necessary to cut the yarn from the ball until after the whipping has been made.

Following are some of the knots, hitches, and bends used by seamen and shipyard riggers.

The Bowline

The bowline is the "king of knots", most certain for security, most typical of seamen, and most useful because it will not slip or jam if properly tied.

How to Tie a Bowline Knot

PROCEDURE

1. Lay the end of the rope over the standing part B, which forms the loop C (Fig. 10). This is called "throwing a bight". Then pass the end up through the bight from the under side.

2. Lead the end around the standing part B and down through the bight. (See Fig. 11).

FIG. 10

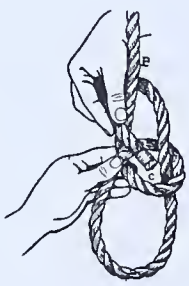


FIG. 11

FIG. 12 — *The Finished Knot*

The Bowline on a Bight

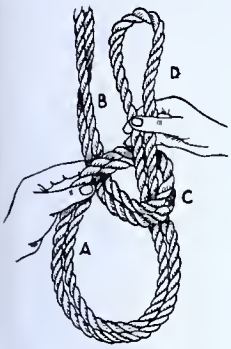


Fig. 13

Fig. 14

Fig. 15

Fig. 16

How to Tie a Bowline on a Bight

Procedure

1. Double the rope as shown in Fig. 13.
2. Take the loop end of the rope A and lay it over the standing part B, forming a bight C.
3. Bring the end of the rope D up through the bight as shown in Fig. 13, and carry the loop D over the standing part, Figs. 14 and 15.
4. Draw up (see Fig. 16), and form the finished knot.

The Double Bowline Knot

As a seat sling, no knot surpasses this one for comfort and safety.

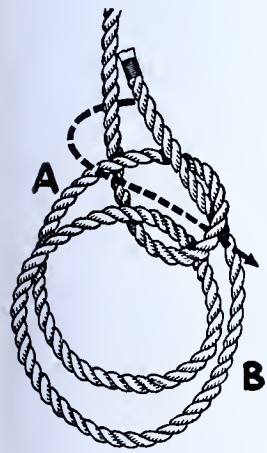


Fig. 17

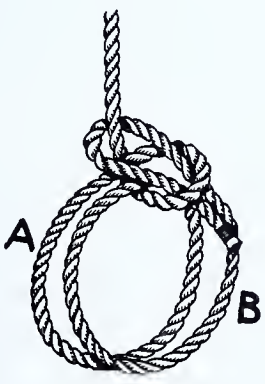


Fig. 18

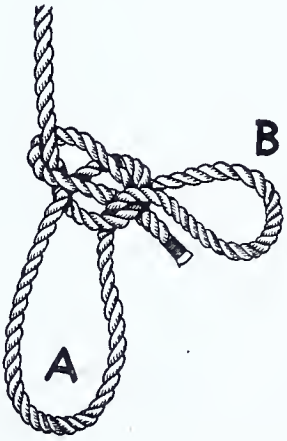


Fig. 19

How to Tie a Double Bowline Knot

PROCEDURE

1. Throw a bight, and pass the end down and up under it twice, as shown in Fig. 17, to form two loops, A and B.
2. Pass the end back around the standing part of the rope down through the bight, and pull tight. See Fig. 18.

The outside loop B is used to go under the armpits while the inner loop A serves as a seat. See Fig. 19.

The Square Knot

Most people tie a "Granny" knot, which slips, instead of a Square Knot.

How to Tie a Square Knot

PROCEDURE

1. Take the two ends and pass the left end A over and under the right end B. (Fig. 20).
2. Then pass end B over and under the end A and draw up tight. (Fig. 21).

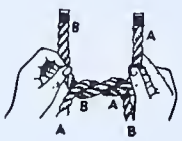


FIG. 20

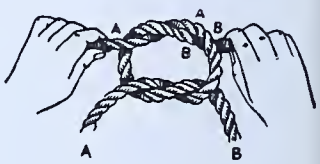


FIG. 21

The square knot, or reef knot, as it is sometimes called, is used for tyin reef points or two ropes, especially of the same size.

The Figure-eight Knot

The figure-eight knot is used to prevent the end of an extended fall fro running out through the hauling block.

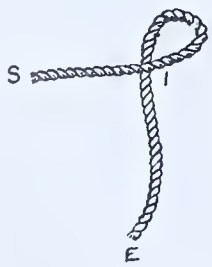


FIG. 22

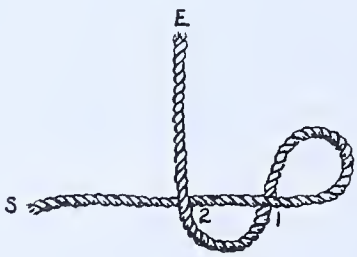


FIG. 23

FIG. 24 — *Figure-eight Knot*

How to Tie a Figure-eight Knot

PROCEDURE

1. Hold the end in the right hand and the standing part in the left hand, and pass the end E under the rope at "1", as shown in Fig. 22.
2. Pass the end E over the rope at "2" (Fig. 23).
3. Pass the end E under the rope at "3" and up through the loop and over the rope at "4", as shown in Fig. 24.
4. Pull the knot tight.

The Half Hitch

Both the half hitch and two half hitches are useful in making fast lines of moderate size.

FIG. 25 — *The Half Hitch*

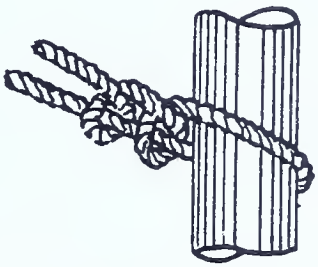


FIG. 26 — *Two Half Hitches*

A Round Turn and Two Half Hitches

A round turn and two half hitches are used for securing mooring lines which have no eyes. The end should be stopped down with a seizing. See Fig. 27.

The Clove Hitch

This is a simple method for fastening a rope around a spar or other object.

To make a clove hitch, pass the end of the rope around the spar or timber and then over itself; then pass the end over and around the spar, under itself, and between the rope and spar. See Fig. 28.

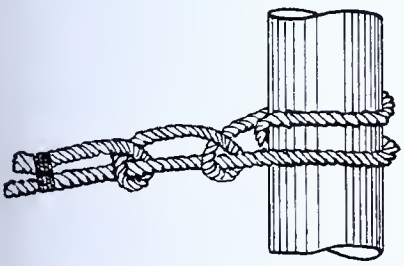


FIG. 27 — *A Round Turn and Two Half Hitches*

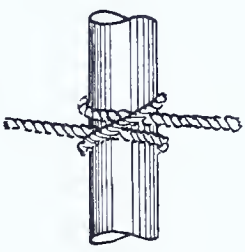


FIG. 28 — *The Clove Hitch*

FIG. 29 — *The Rolling Hitch*

The Timber Hitch

The timber hitch, and timber and half hitches are also used for towing spars.

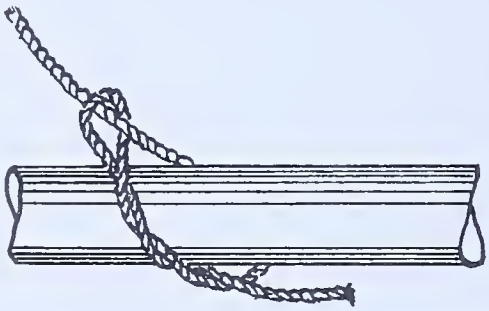


FIG. 30 — *The Timber Hitch*

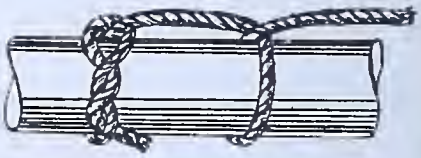


FIG. 31 — *A Timber Hitch and Half Hitch*

The Blackwall Hitch

The single, Blackwall hitch is used when making a temporary fastening to a hook.

The double, Blackwall hitch is more secure.

FIG. 32 — *The Blackwall Hitch*

FIG. 33 — *A Double, Blackwall Hitch*

The Rolling Hitch

When the rigger uses a rolling hitch the pull must be kept steady. Slacking and jerking may loosen it. The pull should be in the same direction as the spar. (Fig. 29).

The Longshoreman's Hitch

The longshoreman's hitch is used to shorten a line. It is very easy to make and unties easily as soon as it is unhooked.

How to Tie a Longshoreman's Hitch

MATERIAL

A line that needs to be shortened

PROCEDURE

1. Hold the rope as shown in Fig. 34, with the bight away from you.
2. Twist the bight of the rope with the right hand, and hold at "A" with the left hand. (Fig. 34A)
3. Bring the bight "B" up through the two parts at "C" as shown in Fig. 34B.
4. Lay the bight which is in the right hand over the bight in the left hand, and lay them both over the hook as shown in Fig. 34C.

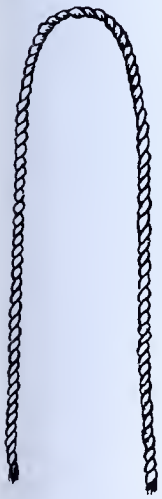


FIG. 34

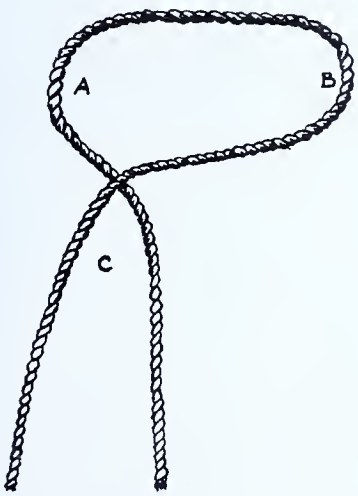


FIG. 34-A

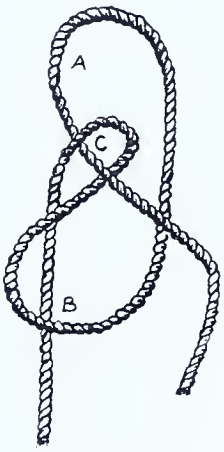


FIG. 34-B

FIG. 34-C — *Longshoreman's Hitch*

How to Tie a Barrel Hitch

A. With a single piece of Manila rope.

MATERIALS

A piece of Manila rope
A keg or barrel

PROCEDURE

1. Stand the barrel on end with the center of the rope under it.
2. Bring one end of the rope up near the top of the barrel and pass it around to form a half hitch.
3. Bring up the other end of the rope near the top of the barrel and pass it around to form a half hitch.
4. Tie the two ends together using a reef or square knot. See Fig. 21.
5. Hook on and hoist the barrel. See Fig. 35.

B. With a strap of Manila rope.

MATERIALS

A strap of Manila rope.
A keg or barrel

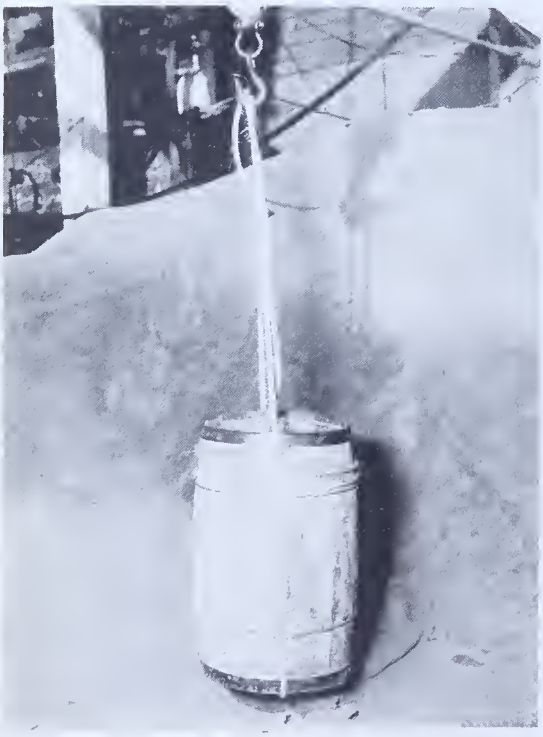


FIG. 35 — *Barrel Hitch Using a Single Piece of Rope*

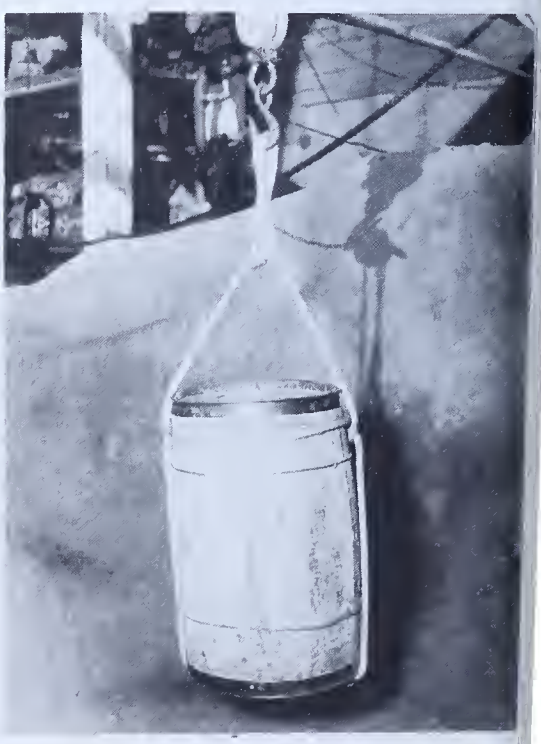


FIG. 35-A — *Barrel Hitch Using a Strap or Sling and a Longshoreman's Hitch*

PROCEDURE

1. Stand the barrel on the strap.
2. Form a half hitch with one side of the strap and place it around the barrel near the top.
3. Do the same with the other side of the strap.
4. Hook on the strap and hoist the barrel (See Fig. 35A).
5. If the strap is too long, make a cat's-paw or a longshoreman's hitch in the strap before placing it over the hook (See Figs. 34C and 38).

The Sheet Bend

The sheet bend, or becket bend, is used for joining two ropes, especially of different sizes.

The Fisherman's Bend

The fisherman's bend is used when fastening a hawser to an anchor.

FIG. 36 — *The Sheet Bend*

FIG. 37 — *The Fisherman's Bend*

FIG. 38 — *The Cat's-Paw*

The Cat's-Paw

The cat's-paw is used to fasten a rope to a tackle.

There are many other knots, hitches, and bends; however, only those commonly used by riggers have been shown.

ASSIGNMENT
Tying Knots, Hitches, and Bends

OBJECTIVE

To learn how to tie knots, hitches, and bends.

TOOLS AND MATERIALS

A piece of rope suitable for tying knots
A nail keg
Paper and pencil

PROCEDURE

1. Whip both ends of the piece of rope.
2. Study the information relative to tying knots.
3. Watch the instructor tie each knot.
4. Practice tying each of the following knots, hitches, and bends to the satisfaction of the instructor.

Bowline knot	Rolling hitch
Bowline on a bight	Timber hitch
Double bowline	Blackwall hitch
Square or reef knot	Double, Blackwall hitch
Figure-eight knot	Fisherman's bend
Half hitch	Sheet bend
Clove hitch	Cat's-paw
Longshoreman's hitch	Barrel sling or hitch

5. Write the answers to the following questions, and then check with the information given.

QUESTIONS

1. **Why is the bowline called the "King of Knots"?**
2. **Name three uses of the bowline knot.**
3. **Why should the ends of the rope be stopped down when the rigger is using a square knot?**
4. **What is the difference between a square knot and a granny knot?**
5. **What is the figure-eight knot used for?**
6. **When does the rigger use a round turn and two half hitches together?**
7. **When is a rolling hitch effective?**
8. **What care should be taken when using a rolling hitch? Why?**
9. **For what is a Blackwall hitch used?**
10. **What is the difference between the single and double Blackwall hitches?**
11. **For what is a sheet bend used?**
12. **For what is a fisherman's bend used?**
13. **For what is a cat's-paw used?**
14. **When should it be used?**

[8]
SEIZING AND SPLICING MANILA ROPE

Seizings

The dictionary gives three definitions for seizing.

1. The operation of fastening together or lashing with small stuff, generally tarred.
2. The cord or lashing so used.
3. The fastening so made is called a seizing. If the parts of the ropes to be seized cross each other it is called a throat seizing. If the ropes are parallel and only one layer is used, it is called a flat seizing.

The seizings commonly used by riggers are: racking seizing; plain, or round, seizing; middle seizing; and throat seizing.

Racking Seizing

This seizing is used to hold together two parts of a fall. The cord is wrapped around the parts of rope like a figure eight.

A stopper with a hook is used when the falls are too far apart for a racking seizing.

FIG. 39 — *A Stopper With a Hook*

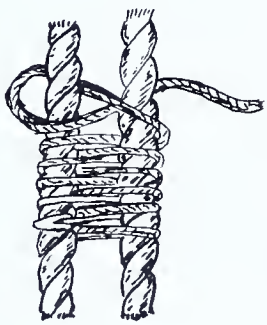


FIG. 40 — *Racking Seizing*

Plain, or Round, Seizing

This seizing is made by wrapping the cord or lashing around the two parts of the rope in a round or circular fashion.

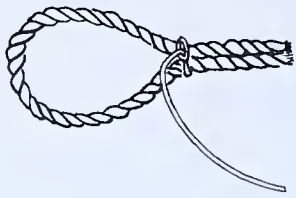


FIG. 41

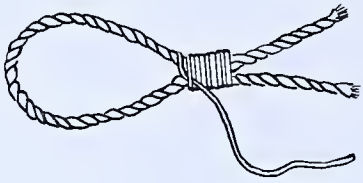


FIG. 41-A

FIG. 41-B — *A Plain, or Round, Seizing*

Middle Seizing

The middle seizing is simply a round seizing around two ropes that must be close to each other.

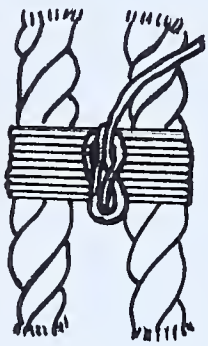


FIG. 42 — *Middle Seizing*

FIG. 43 — *A Throat Seizing*

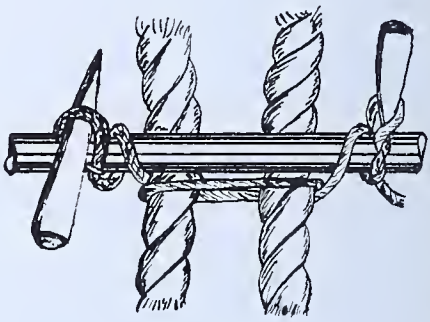


FIG. 44 — *Spanish Windlass*

Eye, or Throat, Seizing

When the ropes cross each other the seizing is called a throat seizing.

When a thimble is used in an eye of Manila rope, the seizing placed around the two parts of the rope is called an eye, or throat, seizing.

The Spanish Windlass

When it is necessary to use pressure to haul two ropes together, a Spanish windlass may be used. It is made up of a bar, a rope, and two smaller bars or marline spikes. After the ropes have been brought together, or as close as necessary, a heavy throat seizing is applied to hold the ropes together.

ASSIGNMENT

Making a Manila Rope Seizing

OBJECTIVE

To learn how to make various kinds of seizings.

TOOLS AND MATERIALS

Rope yarns or marline

2 toggles

1 or 2 parts of Manila rope 2 to 4″ in circumference

A hook

An iron bar

2 marline spikes

PROCEDURE

1. Make a racking seizing.
2. Make a plain, or round, seizing.
3. Make a middle seizing.
4. Make a rope stopper with a hook.
5. Make a Spanish windlass.
6. Make a throat seizing.
7. Have each seizing inspected before you proceed to another.
8. Write the answers to the following questions.

QUESTIONS

1. **What are seizings used for?**
2. **What is a Spanish windlass used for?**
3. **What is a throat seizing?**
4. **How does a racking seizing differ from a plain seizing?**
5. **What is a middle seizing?**

FIG. 45 — *The Above Illustration Shows the Method of Using a Fid in Splicing Manila Rope*

Splicing Manila and Hemp Rope

General Information

Splicing is the operation of joining two parts of the same rope by interweaving the strands so that the resulting joint is about the same size as the original rope; splicing is also the joining together of two separate ropes.

The splices used by riggers are: the short splice, the eye splice, the long splice, the cut splice, and the back splice.

In a short splice each strand of each rope is carried over the adjacent strand and tucked under the second strand, and so on.

In the eye splice the end part of the rope is bent into a loop and then spliced into the standing part with a short splice.

The long splice is made by unlaying one strand of each rope, replacing it by a strand of the other rope, and then fastening by knots, with resulting joints no larger than the original rope; never less than four tucks should be used.

Four to five tucks are recommended.

A fid is a tapered and pointed wooden spike used to open the strands for splicing Manila or hemp rope. The fid is made of maple, hickory, or other hard wood.

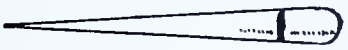


FIG. 46 — *A Fid*

How to Make a Short Splice*

PROCEDURE

1. Unlay the strands of the rope for a short distance, seize the ends of the strands to prevent untwisting, and put the ropes together as shown in Figure 47, alternating the strands from each end.

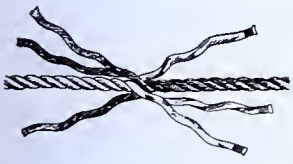


FIG. 47

FIG. 48

FIG. 49

2. Now tie down one set of strands temporarily, and tuck any strand of the opposite set over and under one strand of the rope. Figure 48.

FIG. 50

FIG. 51

FIG. 52

3. Tuck against the twist or "lay" of the rope. The tuck goes over one strand, under the second, and out between the second and third. Figure 49.
4. Repeat the same operation with the other two strands from the same end of the rope. Figure 50.
5. Remove the tie from the other strands. Repeat the operation on the other side of the rope. Figure 51. Continue two more tucks for each of the six strands.

*By courtesy of the Plymouth Cordage Company.

6. To finish, roll and pound the rope on a hard surface. Do not cut the ends of the strands off too close! Figure 52.

For the tapered splice, top picture of Figure 52, take two more tucks with each strand; but before the first tuck, cut out one-third of the yarns from each strand. Then tuck. Now, cut strands again, removing one-half of the remaining yarns; tuck again.

When to Use a Short Splice

The short splice, although the strongest way to join two ropes, should not be used on pulley work, as the rope is nearly doubled in size at this point and exposes the strands to extra chafing.

An Eye Splice

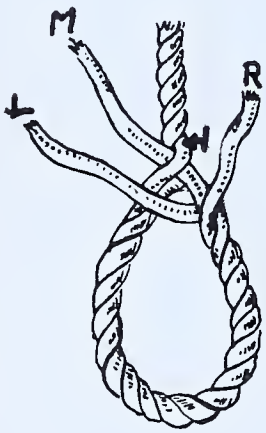


Fig. 53

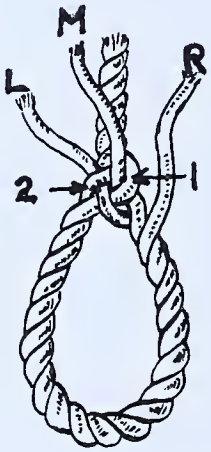


Fig. 54

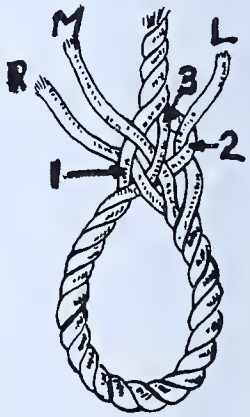


Fig. 55

How to Make an Eye Splice

Procedure

1. Unlay the rope for a distance sufficient to make four tucks.
2. Hold the bight in the left hand, place the unlaid part of the rope over the bight, and hold the middle strand M over strand 2 with the thumb and first finger of the left hand.
3. Tuck the middle strand M under strand 1 as shown in Fig. 53.
4. Lay strand L over strand 1 and tuck it under strand 2 as shown in Fig. 54.

5. Now turn the splice over, and tuck strand R under strand 1 as shown in Fig. 55.

6. Continue tucking the strands in the same order as in the short splice.

ASSIGNMENTS

Making a Short Splice in Manila Rope

OBJECTIVE

To learn how to make the various Manila-rope splices.

TOOLS AND MATERIALS

A piece of Manila rope
A fid

PROCEDURE

1. Follow the procedure shown in the information sheet.
2. Have the finished splice inspected by the instructor. Ask for any necessary help as you proceed.
3. Write the answer to the following question.

QUESTION

1. How does the making of a short splice differ from the making of a long splice?

Making an Eye Splice in Manila Rope

OBJECTIVE

To learn how to make the various Manila-rope splices.

TOOLS AND MATERIALS

A piece of Manila rope
A fid

PROCEDURE

1. Follow the procedure shown in the information sheet.
2. Have the finished splice inspected by the instructor. Ask for any necessary help as you proceed.
3. Write the answers to the following questions.

QUESTIONS

1. What is a fid?
2. What is a fid made of?
3. How are the strands tucked in a right-handed rope?

How to Make a Long Splice*

PROCEDURE

1. Unlay the end of each rope about fifteen turns, and place the ropes together, alternating the strands from each end as shown in Fig. 56.

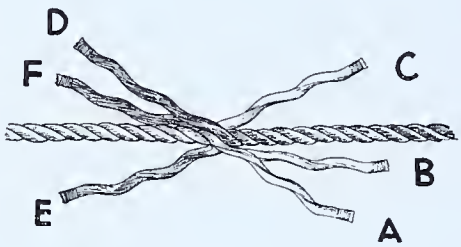


FIG. 56

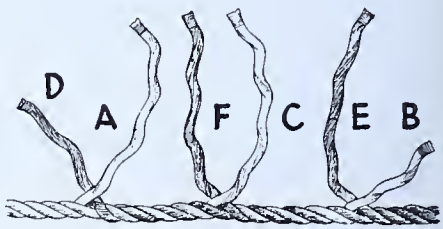


FIG. 57

2. Start with any opposite pair, unlay one strand, and replace it with strand from the other part. Repeat the operation with another pair of strands in the opposite direction as shown in Fig. 57.

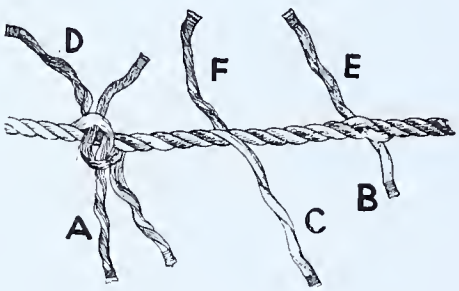


FIG. 58

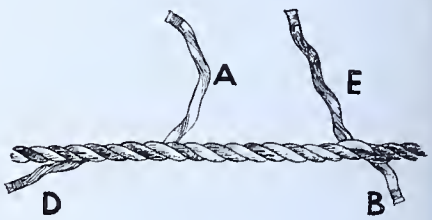


FIG. 59

3. Now tie each pair of opposing strands, Fig. 58, with an overhand kn like B and E; tuck each strand twice, as in the short splice; and then tuc twice more as for the tapered splice. Or, halve each strand (see A and D and tie with an overhand knot before tucking. By this latter method small splice results, but at a considerable sacrifice of strength.

4. Roll and pound well before cutting strands off close to rope. Figure 5

*By courtesy of the Plymouth Cordage Company.

How to Make a Cut Splice

The cut splice is made in the same manner as the eye splice. Two separate tuckings are necessary to form the eye in the bight of the rope. See Fig. 60.

FIG. 60 — *A Cut Splice*

How to Make a Crown

PROCEDURE

Bend the strands of the rope over each other as shown in Figs. 61 and 62.

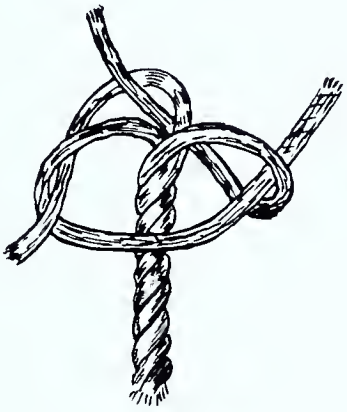


FIG. 61

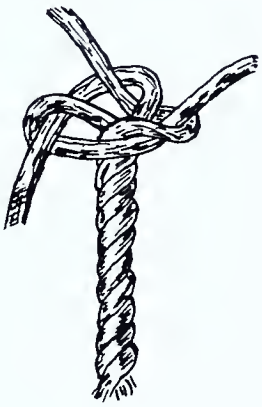


FIG. 62 — *A Crown*

How to Make a Back Splice

PROCEDURE

1. Crown the strands the same as shown above.
2. Splice the strands back into the rope the same as in the short splice.
3. Place a whipping around the rope at the ends of the strands.

FIG. 63 — *A Back Splice*

How to Make a Grommet

PROCEDURE

1. Use a single strand of rope four times as long as the circumference of the finished grommet. Form a circle of the size wanted.
2. Lead the long end of the strand around, following the grooves or "lay" of the strand, until you are back where you started. You now have a two-stranded ring as shown in Fig. 64.

3. Continue twisting the free end between the turns already made until the three-stranded ring is complete.
4. Tie the ends with an overhand knot.
5. Pass the remaining ends under the nearest strands, and trim closely.

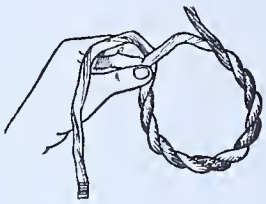


Fig. 64

Fig. 65 — *A Grommet*

If a strong twist is kept on the strand while laying up the grommet, th finished ring will be as smooth as a finished rope.

How to Make a Cringle

A cringle is an iron or rope thimble or grommet worked into or attache to the edges and corners of a sail, used for making fast the bowline bridles earrings, etc.; also, in light sails, an eyelet worked in the sail itself.

Procedure

1. Use a single strand of rope four times the length of the cringle, and tuck one end into the rope.

Fig. 66

2. Tuck the other end through the rope at a distance according to the size of the cringle, and follow the grooves or "lay" of the first loop back to the starting point. See Fig. 66.

Fig. 67 — *A Cringle*

Fig. 68 — *A Cringle on a Sail*

3. Tuck the end under the next strand on the bight of the rope, and follow the "lay" back to the other end of the cringle. See Fig. 67.

When turning a cringle on the leech of a sail, the rigger passes the en through the eyes or grommets in the sail as shown in Fig. 67.

4. Now splice the ends into the rope away from the cringle.

ASSIGNMENTS

Making a Grommet

OBJECTIVE

To develop skill in making rope equipment.

TOOLS AND MATERIALS

A single strand of rope of suitable size

PROCEDURE

1. Follow each step as shown in the information given.
2. Make four grommets; they will be convenient for use as quoits.

Making a Cringle

OBJECTIVE

To learn how to make various rope equipment used by riggers.

TOOLS AND MATERIALS

A single strand of rope of suitable size
A stiff, four-stranded, hemp boltrope

PROCEDURE

1. The cringle is very much like the grommet. Use a single strand of rope, and proceed as shown in the information sheet.
2. Making a cringle is a difficult job and should be very carefully done.

Worming, Parceling, and Serving

When rope has to be covered, it is first wormed by laying smaller rope, or worm, along the contline of the rope. This helps to make the surface more nearly round. Next the parceling is done. Long, narrow strips of canvas, usually daubed with tar, are wound about the rope like a bandage to make a smooth surface. The serving, usually of marline, is then wound around the parceling with the help of a serving mallet or serving board. Figure 28 shows a piece of wire rope being served. The procedure is the same for Manila or hemp rope.

The worming and parceling is put on with the lay of the rope, and the serving is wound the other way, or against the lay of the rope.

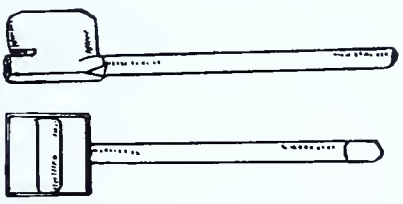


FIG. 69 — *Serving Boards*

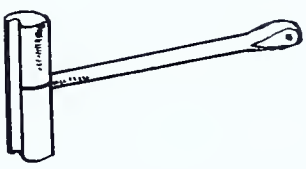


FIG. 70 — *A Serving Mallet*

ASSIGNMENT

Worming, Parceling, and Serving

OBJECTIVE

To learn how to protect the splice and make it stronger.

TOOLS AND MATERIALS

Line for worming

Canvas for parceling

Marline for serving

Serving board or serving mallet

PROCEDURE

1. Follow the procedure shown in Information Sheet No. 8.
2. Have each step inspected before proceeding to the next.
3. Write the answers to the following questions.

QUESTIONS

1. **What kinds of line are used for worming?**
2. **What kinds of line are used for serving?**
3. **What is the rule for worming, parceling, and serving?**

[9]
BLOCKS AND FALLS*

General Information

A tackle (pronounced taykle) is an assemblage of ropes and pulleys arranged for hoisting and pulling. The uses of a tackle are to change the point of application of the pulling force to a convenient place, and to enable a small force to overcome a larger resistance. Tackles are variously designated according to the number of sheaves in their blocks, as single, double, or twofold tackles, etc., or according to the place, purpose, or manner of use.

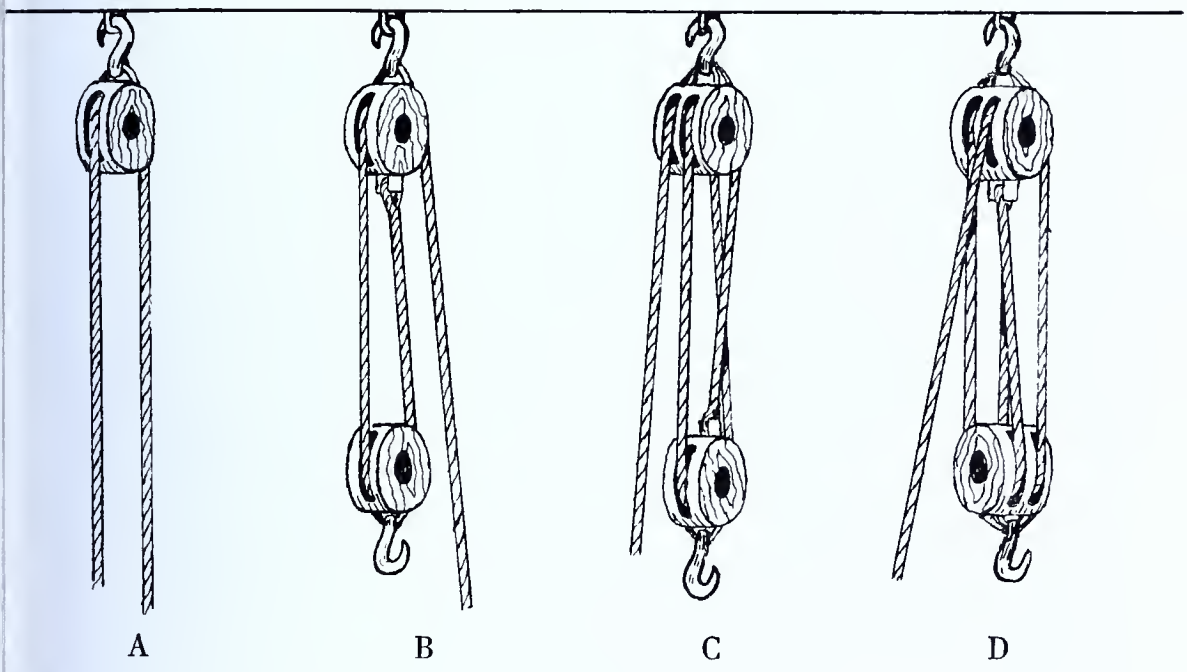


Fig. 71 — *Various Tackles Commonly Used by Riggers*

Common Forms of Tackles

A. The single-whip tackle consists merely of a rope passed through a fixed single block.

B. The gun tackle, formerly used for moving guns, is a tackle in which only half the power is required to lift the weight (disregarding friction).

*Adapted from information furnished by the Boston and Lockport Block Company and the Plymouth Cordage Company.

C. The luff or "handy billy" consists of a single and a double block with the standing part of the fall fixed to the former, thus multiplying the power three or four times, according to whether the single or double block is movable (disregarding friction).

D. A twofold tackle consists of two double blocks; the power gained is four or five times according to which block is movable.

The power gained by men using a tackle to lift loads will be the sums of their weights times the number of parts of rope between the blocks less the friction loss caused by the various factors: the condition of the block, the diameter of the sheaves, and the resistance caused by bending the rope around the sheaves.

Various other combinations of double and triple blocks, of two triple blocks, and other sizes of blocks are used for lifting heavy loads.

In heavy purchases the falls are crossed so that the hauling part reeves through the middle sheave. This keeps the blocks from turning over while lifting or hauling a load.

The standing part of a rope or fall is that part which is secured to the becket of the block.

The hauling part of a rope or fall is that part which has the loose end and upon which the pull is applied.

How to Find the Pull Required to Lift a Given Weight

When the weight to be lifted and the number of parts at the movable block are known, divide the weight by the number of parts at the movable block to get the mechanical advantage or necessary pull to lift the weight, disregarding any loss by friction. But there is always a friction loss around sheaves, and a rule which is safe, but only approximate, is to allow 10 friction loss for each sheave that is 3″ or more in diameter. Add this fractional loss to the load, and proceed as if friction were not present.

Example 1

How much pull will be required to lift 100 lbs. with 1 single and 1 double block? The tackle consists of sheaves and 3 supporting parts, or has a mechanical advantage of 3. Allow 10% friction loss for each sheave.

Solution:

3 x 10% = 30% = Total amount of friction.

30% of 100 lbs. = 30 lbs.

100 lbs. + 30 lbs. = 130 lbs. = Total amount to be lifted.

$\frac{130 \text{ lbs.}}{3} = 43.3$ lbs. = the pull required to lift 100 lbs.

A more accurate computation is as follows:

$$\frac{100 \text{ lbs.}}{3 \text{ x } .90 \text{ x } .90 \text{ x } .90} = 45.75 \text{ lbs.}$$

The factor .90 represents the 90% efficiency of each sheave and should appear in the denominator of the fraction as many times as there are sheaves in the tackle.

Example 2

How much pull will be required to lift 100 lbs. with 2 double blocks which consist of 4 sheaves with a mechanical advantage of 4?

Solution:

4 x 10% = 40% = Total friction loss

40% of 100 lbs. = 40 lbs.

100 lbs. + 40 lbs. = 140 lbs. = Total amount to be lifted.

140 lbs. ÷ 4 = 35 lbs. = Pull required to lift load.

Second method:

$$\frac{100 \text{ lbs.}}{4 \text{ x } .90 \text{ x } .90 \text{ x } .90 \text{ x } .90} = 38.1 \text{ lbs.}$$

Types of Purchase	Theoretical Increase of Power	Actual Increase of Power	Efficiency
	Times	*Times*	*Percentage*
One single sheave block	1	0.9	90
Two single sheave blocks	2	1.74	85
One single sheave block and one double sheave block	3	2.35	78
Two double sheave blocks	4	2.76	72
One double sheave block and one triple sheave block	5	3.5	70

These figures are for Metaline-Bushed Wood Blocks for Manila rope.

The efficiency of wire-rope blocks where sheave, sheave-groove, and wire-rope sizes are correct is higher than the efficiency for Manila-rope blocks.

(When hook blocks are used the loads applied should be 30% to 40% less than with shackle blocks.)

Parts of a Block

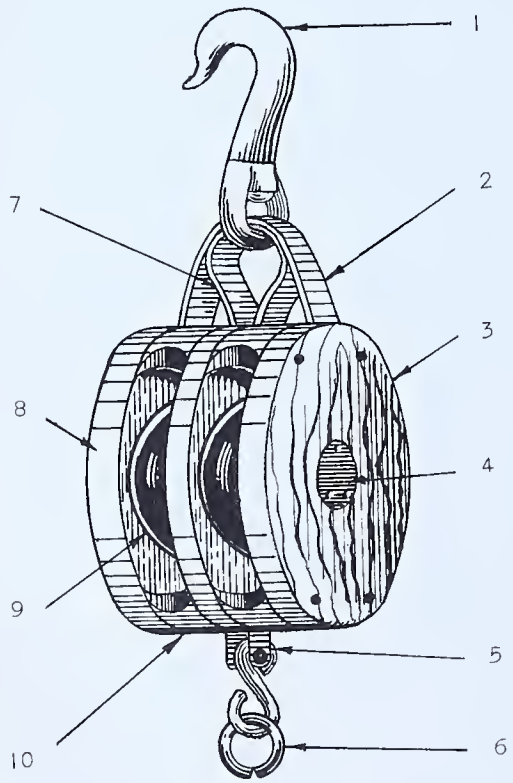


FIG. 72 — *Showing the Various Parts of a Block*

1. Hook
2. Outer Strap
3. Shell
4. Pin
5. Becket
6. Thimble
7. Inner Strap
8. Cheeks
9. Sheave
10. Breech

Kinds of Blocks for Manila Rope

Regular Mortise Inside-Strapped Blocks

FIG. 73 — *Single*

FIG. 73-A — *Double*

FIG. 73-B — *Triple*

Blocks With Swivel Hooks

FIG. 73-C — *Without a Becket*

Block With Sister or Match Hooks

FIG. 73-D — *With a Becket*

Block With Shackle and Becket

FIG. 73-E — *Single*

FIG. 73-F — *Single*

Cargo blocks are blocks with a wide swallow and are mounted with a swivel link and shackle, or a swivel hook.

Lead blocks are blocks slung to the mast table under the booms, giving a fair lead to the cargo whips from the cargo block down to the drum of the winch.

Boatfall blocks are used to raise and lower lifeboats and are usually provided with special fittings for releasing quickly.

Snatch blocks are blocks which can be opened on one side to receive the bight of a rope.

Snatch blocks are used to make the application of power easy, as, for example, to move or haul loads horizontally.

Gin blocks are iron or steel tackle blocks, containing one or more pulleys. They are sometimes called whip gins and monkey wheels. They generally have a guard to keep the rope from running off the score of the sheave.

FIG. 74 — *A Cargo Block With a Swivel Hook*

FIG. 74-A— *A Cargo Block With a Swivel Eye*

FIG. 75 — *A Snatch Block*

FIG. 76 — *A Gin Block*

Hooks For Manila Rope

Table II — Eye Hooks

Size Number	DIMENSIONS Inches: Length Overall	Inside Diameter of Eye	Throat Opening	Approximate Weight Each Pounds
21	3 3/16	13/16	3/4	3/8
22	4 5/16	1	1	1/2
23	5 1/4	1 1/8	1 1/16	3/4
24	5 3/4	1 1/4	1 1/8	1 1/4
25	6 1/2	1 7/16	1 1/4	2
26	7	1 1/2	1 3/8	2 1/2
27	7 3/4	1 5/8	1 1/2	3 1/2
28	9	1 3/4	1 11/16	4 7/8
29	10	1 7/8	1 7/8	6 1/8
30	10 1/2	2	2	7 3/8
31	11 3/8	2 1/4	2 1/16	10 1/4
32	12 3/4	2 1/2	2 1/2	14
33	14 3/4	2 7/8	3	20 3/4
34	15	3	3 3/8	25 1/2
36	18	3	4	43 1/2

FIG. 77 — *Reversed Eye Hook*

FIG. 77-A — *Front Eye Hook*

Table III — Swivel Hooks

Size Number	DIMENSIONS Inches: Length Overall	Size of Swivel	Throat Opening	Approximate Weight Each Pounds
2	5 3/8	3/8	1	3/4
3	6 1/4	1/2	1	1 1/8
4	7	9/16	1 1/16	1 7/8
5	7 1/2	9/16	1 3/16	2 3/8
6	8 1/2	5/8	1 1/4	3 1/4
7	9	5/8	1 3/8	4 1/4
8	10 1/2	3/4	1 3/4	6 1/2
9	11 1/4	3/4	1 13/16	7
10	13 1/4	1	1 7/8	11
11	14	1	2	13
12	15 1/2	1 1/8	2 1/4	18
13	17	1 1/4	2 5/8	25
14	17 1/2	1 1/4	3 3/8	33

FIG. 77-B — *Swivel Hook*

Table IV — Working Loads

SIZE NUMBER Table III	SIZE NUMBER Table II	Working Loads Tons
	21	.4
2	22	.5
3	23	.6
4	24	.7
5	25	1.2
6	26	1.7
7	27	2.1
8	28	2.5
9	29	3.
10	30	4.
11	31	4.7
12	32	5.5
13	33	6.8
14	34	8.5
	36	15.

Table V — Cargo Hooks

Size Number	Working Load Tons	Length of Hook Inches	Approximate Weight Each Pounds
20	1	8 7/8	4
21	2 1/2	10 1/2	7 1/2
22	5	13	14 1/2

Size Number	Working Load Tons	Length of Hook Inches	Approximate Weight Each Pounds
0	1	8 7/8	6 1/4
1	2 1/2	10 1/2	12 3/4
2	5	13	23

Size Number	Working Load Tons	Length of Hook Inches	Approximate Weight Each Pounds
31	2 1/2	10 1/2	21
32	5	13	35

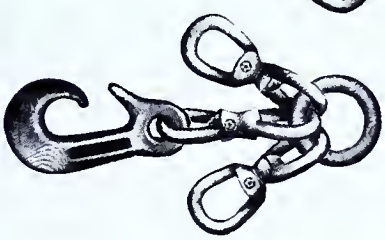
Size Number	Working Load Tons	Length of Hook Inches	Approximate Weight Each Pounds
41	2 1/2	10 1/2	28
42	5	13	44

FIG. 78 — *Portland Pattern*

FIG. 78-A *Liverpool Pattern*

FIG. 78-B — *Western Pattern*

FIG. 78-C— *Seattle Pattern*



Hooks should always be moused when there is danger of their unhooking. Serving wire or a small shackle makes a good mousing and strengthens the hook to a considerable extent.

How to Make Up a Tackle

1. Have the blocks about three feet apart.
2. Place the blocks down with the points of the hooks up and with the hooks pointing the same way.
3. Coil the fall around the blocks.
4. Clove-hitch the end of the fall around the tackle between the blocks.

FIG. 79 — *Hook Moused With Wire or Marline, etc.*

FIG. 79-A — *Hook Moused With a Shackle*

The tackle is now ready to be stowed away without danger of becoming tangled.

Reeving Tackle Blocks

When reeving off a pair of tackle blocks (the UPPER block having three sheaves), the preferred method, as per illustrations, would have the PULL rope lead from the center sheave of the UPPER block. When rove in this manner, the hoisting strain rests on the center of the blocks and keeps them from toppling over with consequent injury to the rope by rubbing across the edges of the block shell. To reeve off blocks by this method, the two blocks should be arranged so that the sheaves in the upper block are at right angles to those in the lower block. Figs. 80, 80A, and 80B.

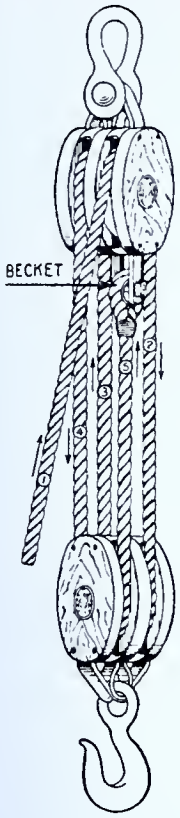


FIG. 80
Double and Double

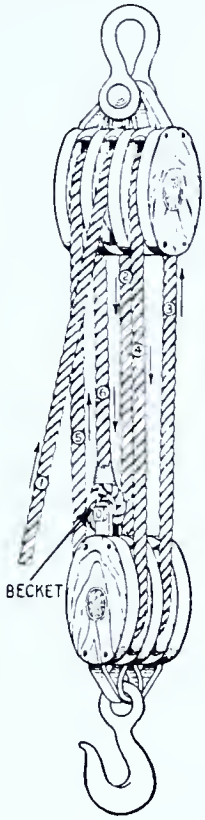


FIG. 80-A
Triple and Double

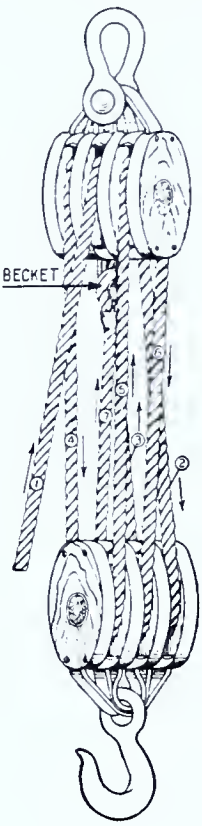


FIG. 80-B
Triple and Triple

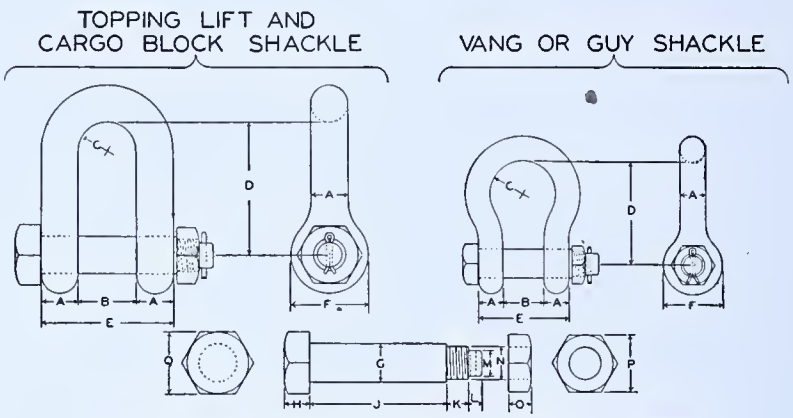
When the rigger uses a pair of blocks, he should provide a shackle connection for the upper block and a loose hook or a swivel hook for the lower block. The shackle connection is much stronger than a hook connection and will handle the extra strain on the upper block, which supports both load and pull. The lower block supports only the load. The hook on the lower block is more convenient to attach to loads.

Shackles

FIG. 81 — *Anchor Type*

Size — inches
3/4
7/8
1
1 1/8
1 1/4
1 3/8
1 1/2
1 5/8
1 3/4
2

FIG. 81-A —
Chain Type



TYPE	FINISH	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	COTTER
CARGO BLOCK	GALV.	1 3/8	2 1/4	1 1/8	5 1/2	5	3 1/4	1 1/2	15/16	5 1/8	13/16	1/2	1"	1 3/8	15/16	2 3/16	2 3/8	1/4"
VANG	GALV.	1"	1 5/8	1 1/16	4 7/16	3 5/8	2 3/8	1 1/8	5/8	3 1/4	9/16	1/2	7/8	1"	9/16	1 7/16	1 5/8	1/4"

FIG. 82 — *Method of Application*

Swivels

FIG. 83
Swivel With Jaw End

FIG. 83-A
Swivel

NOTE: — For wire-rope fixtures see Information Sheet No. 15.

ASSIGNMENTS

Testing the Advantage of Blocks and Falls

OBJECTIVE

To test the advantage of using blocks and falls in lifting loads.

TOOLS AND MATERIALS

6-inch, wood-shell, double-sheave blocks and falls
Two 5-gallon buckets
Scales
125 lbs. of sand

PROCEDURE

1. Study the information on Tackles.
2. Fasten double and double-sheave blocks and falls to a beam overhead

3. Fill a bucket with sand until it weighs 50 lbs., and hang it on the load hook.
4. Fasten an empty bucket to the hauling part so that it clears the floor about one foot.
5. Now fill the empty bucket with sand until it lifts the 50 lbs. off the floor.
6. When the two buckets balance, weigh the one on the hauling part. It should weigh 12½ lbs. plus the friction. Multiply the difference in weight by .72, and you will have the percentage of friction involved in a double-sheave block and fall. (.72 is found in the efficiency column of the table on page 62.)
7. Use the above procedure to test other blocks and falls.

QUESTIONS

1. **How much power is gained by using a single-whip tackle (disregard friction), a runner tackle, a handy billy?**
2. **In making heavy purchases, why is the hauling part rove to come through the middle sheave in the top block?**
3. **What is the percentage of friction caused by using a twofold tackle or double-sheave block and fall?**
4. **What share of the load on the tackle comes on the hauling part?**
5. **What is the standing part of a fall?**
6. **What is the hauling part of a fall?**

Using Different Kinds of Blocks

OBJECTIVE

To learn the advantage of using different kinds of blocks.

TOOLS AND MATERIALS

A single whip

A luff tackle

PROCEDURE

1. Proceed as in the previous assignment, using increasing amounts of sand in the bucket on the hauling end until the load is lifted.
2. Weigh the bucket of sand on the hauling part.
   1. The difference in weights of the two buckets on a single-whip tackle is due to friction.

2. Because more than 50 lbs. is required to lift an even 50 lbs., it is evident that the difference must equal the amount of energy lost by friction. Multiplying this difference by 2 will give the percentage of friction generated.
3. The amount of friction is increased by the number of sheaves.
4. When luff tackle is used, the power, or weight of sand, necessary to lift 50 lbs. will be 1/3 of 50 lbs. plus the friction. To get the percentage of friction multiply by two. If 100 lbs. were being lifted, the difference would be in hundredths, or percentage.

3. Write the answer to the following question.

QUESTION

1. How much power is gained by using a single-whip tackle, a gun tackle, a luff tackle, a twofold tackle?

Making Up a Tackle

OBJECTIVE

To learn the proper way to keep the ropes of a tackle from becoming tangled during storage.

TOOLS AND MATERIALS

Blocks and falls

PROCEDURE

1. Proceed according to the information sheet.
2. Write the answers to the following questions.

QUESTIONS

1. What is the most secure and handy knot to use in making up a tackle for storage or transportation?

2. Why should a tackle be made up?

[10]
KINDS OF WIRE ROPE*

General Information

Wire rope is manufactured from various grades of steel, ranging all the way from iron to improved plow steel. It may be galvanized for use where corrosive conditions prevail.

To meet the demand for strength, toughness, ability to withstand abrasive wear, and resistance to corrosion in varying degrees for the many purposes for which wire rope is used, it is manufactured in the following grades:

Iron is a low tensile strength. It is soft and ductile, and its field is limited because of its low strength and comparatively low resistance to abrasion.

Cast Steel is the lowest in strength of the four standard grades of steel wire ropes. While cast-steel ropes are tough, their use is limited because of the comparatively low strength and low resistance to abrasion.

Mild Plow Steel is stronger and better adapted to withstand abrasion than cast steel. It is used on installations requiring ropes capable of high fatigue resistance, where strength is not of primary importance. It is also known as Extra-strong Cast Steel.

Plow Steel is both stronger and more wear-resistant than the lower grades of steel used in the fabrication of wire ropes. It is extensively used on many types of equipment.

Improved Plow Steel is the strongest of the standard grades, and is best suited for severe service conditions. Its high-carbon and high-manganese content produces maximum abrasion-resisting qualities. This is the grade used on most crane hoists, slings, and pendants.

Stainless Steel is the latest addition to the metals used for producing wire ropes. The 18 per cent chromium and 8 per cent nickel alloy, commonly known as "18-8", has filled the need for a corrosion-resistant wire rope for both marine and industrial use.

*The source of material for this information was furnished by the American Steel and Wire Company, and Wickwire Spencer Steel Company.

Bronze is used to a limited extent for fabricating wire ropes. Bronze-wire ropes are of both commercial bronze (90% copper; 10% zinc)and phosphor bronze. Phosphor-bronze ropes are the stronger and tougher of the two.

Galvanized ropes, in which the individual wires are protected by a uniform coating of pure zinc, are made in Iron, Cast Steel, and Plow Steel grades. These are used where ropes are exposed to the weather, to moisture, or to other corroding agencies; and their field is usually limited to stationary installations such as guys, standing rigging, towing hawsers, mooring lines, and the like. Heavily lubricated bright ropes are generally preferred to galvanized ropes on hoisting equipment where corrosive conditions prevail.

Gauging

The diameter of a wire rope is the diameter of the circle which will just enclose all of the strands. In the case of strands, the diameter is that part of the circle which will just enclose all of the wires. The correct diameter is the greatest diameter of the rope or strand.

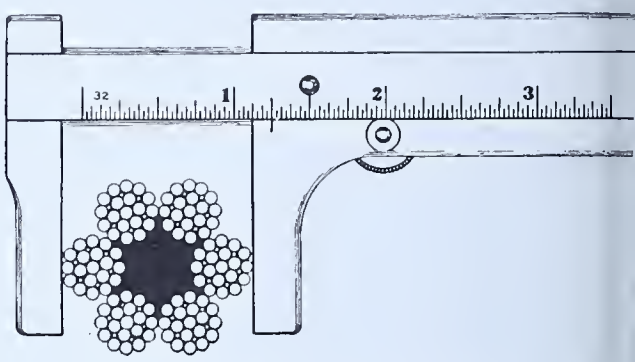
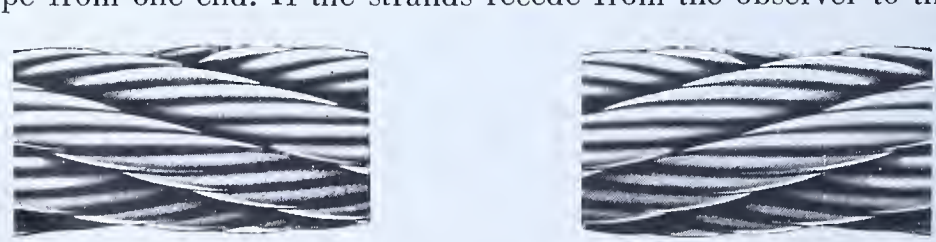


Fig. 84 — *Correct Way to Gauge Wire Rope*

Wire-Rope Lays

Throughout this article on lays and strands, any reference to lay will mean the construction and direction of the stranding in the rope as a whole, and any reference to stranding or type of strand will mean the direction of the individual wires in the separate strands. In other words when speaking of the rope as a whole we have left-lay and right-lay. In speaking of the wires in a strand we have Lang strand, reverse strand and regular strand.

The direction of lay in a wire rope is established by looking down along the rope from one end. If the strands recede from the observer to the right



Right Lay *Left Lay*

Fig. 85 — *Wire Rope Lays*

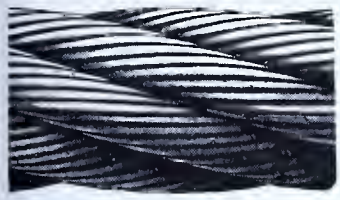


FIG. 86 — *Regular Strand*

FIG. 87 — *Reverse Strand*

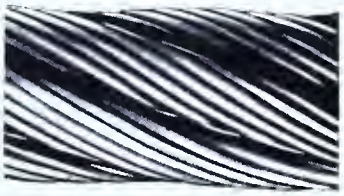


FIG. 88 — *Lang Strand*

or in a clockwise direction the lay is right; if the strands recede from the observer to the left or in a counter-clockwise direction the lay is left.

RIGHT LAY OR LEFT LAY depends on whether the strands of the rope rotate to the right or to the left while receding from the observer and when viewed from above. Right lay is the standard. There are very few types of installations requiring the use of left-lay wire rope.

REGULAR STRAND, the accepted standard for wire rope, denotes ropes in which the wires are twisted in one direction to form the strands, and the strands in the opposite direction to form the rope. In regular-strand ropes, the outer wires are approximately parallel to the longitudinal axis of the rope. Because of the difference in direction of the strand and rope lays, regular ropes are less likely to kink and untwist; therefore they are easier to handle than Lang-strand ropes. Regular-strand ropes are less subject to failure from crushing and distortion, because of the shorter length of exposed outer wires.

LANG-STRAND wire ropes have the wires in the strands, and the strands in the rope, twisted in the same direction. The outer wires run diagonally across the longitudinal axis of the rope, and are exposed for longer lengths than in regular-strand ropes. Because of the longer length of exposed outer wires, which presents greater wearing surface, Lang-strand ropes have increased resistance to abrasion. They also possess greater flexibility and greater resistance to fatigue than regular-strand ropes.

Greater care must be exercised when handling Lang-strand ropes, as they are more likely to kink and to untwist than regular-strand ropes. They are also less resistant to abuse from distortion and crushing. Lang-strand ropes should have both ends permanently fastened to prevent untwisting. They are not recommended for installations where the untwisting tendency cannot be controlled, such as single-part hoists; and they should not be used with a swivel type and terminal.

REVERSE-STRAND applies to ropes in which the strands are alternately regular-strand and Lang-strand. The use of reverse-strand ropes is usually limited to certain types of conveyors. The standard direction of lay is right, as it is for both regular-strand and Lang-strand ropes.

Selecting Wire Rope

When selecting a wire rope to give the best service, the rigger should consider four requirements. A proper choice is made by correctly estimating the relative importance of these requirements and selecting a rope which has the qualities best suited to withstand the destructive effects of continued use.

The rope should possess:

Strength sufficient to take care of the maximum load that may be applied with a proper factor of safety.

Ability to withstand repeated bending without failure of the wires from fatigue.

Ability to withstand abrasive wear.

Ability to withstand distortion and crushing, or, to put it more plainly, the ability to withstand abuse.

Strength

Wire rope in service is subjected to several kinds of stresses. The stresses most frequently encountered are direct tension, stress due to acceleration, stress due to sudden or shock loads, stress due to bending, and stress resulting from several forces acting at one time. For the most part, these stresses can be converted into terms of simple tension, and a rope of approximately the correct strength can be chosen. Since the strength of a wire rope is determined by its size, grade, and construction, these three factors should be considered.

Safety Factors

The safety factor is the ratio of the strength of the rope to the working load. Thus, a wire rope with a strength of 10,000 pounds and a total working load of 2,000 pounds would be operating with a safety factor of five.

It is not possible to set proper safety factors for the various types of equipment using wire rope. This factor can safely vary with conditions on individual units of equipment. The proper safety factor depends not only on the loads applied, but also on the speed of operation, the type of fittings used for securing the rope ends, the acceleration and deceleration, the length of rope, the number, size, and location of sheaves and drums, the factors causing

abrasion and corrosion, the facilities for inspection, and the possible loss of life and property should a rope fail.

The following tables of minimum safety factors are submitted only as a guide. These have been established by experience as the minimum safety factors required for safety and economy on the average installation. Larger safety factors are desirable, as they represent greater safety and, in most cases, increased economy.

Table VI
MINIMUM SAFETY FACTORS

Type of Service	Minimum Safety Factor
Miscellaneous Hoisting Equipment	5.0
Haulage Ropes	6.0
Overhead and Gantry Cranes	6.0
Jib and Pillar Cranes	6.0
Derricks	6.0
Small Electric and Air Hoists	7.0
Hot Ladle Cranes	8.0
Slings	8.00

Minimum Factor of Safety

The safety factor of operation of wire rope is the ratio between the rated breaking strength of a rope and the load applied to the rope. To find the safety factor divide the rated breaking strength by the weight of the load applied. For example, if a rope with a rated breaking strength of 36 tons is used to lift 6 tons, the safety factor will be 36 ÷ 6, or 6. The applied rope load must be computed by always taking into consideration the increased loads due to starting and stopping and frictional resistance.

The following minimum safety-factor values have been established by long experience as being conducive to good rope service:

Table VII
MINIMUM SAFETY FACTORS

Use of Rope	Minimum Factor of Safety
Static ropes and strands for guying	3 to 4
Aerial truck cables, for material movement	3½ to 4
Each operating rope on a clamshell bucket	4 to 5
Haulage rope on a horizontal haulage system	4 to 5
Industrial hoists, stationary and movable cranes, and building material	6

Tables VI and VII were taken from two different sources for comparison.

ASSIGNMENT

Selecting and Gauging Wire Rope

OBJECTIVE

To become familiar with the different kinds of wire rope used by riggers.

TOOLS AND MATERIALS

A slide caliper

Several pieces of different sizes and kinds of wire rope

PROCEDURE

1. Examine each piece of wire rope carefully to see how it is constructed.
2. With a slide caliper measure the size of each piece of wire rope. (Make sure to take the caliper readings of the larger diameters.)
3. Examine each piece of wire rope, and note which are regular-strand and which are Lang-strand.
4. Write the answers to the following questions.

QUESTIONS

1. **List the materials from which wire rope is made.**
2. **How is the right or left lay of a rope determined?**
3. **Why are some wire ropes galvanized?**
4. **What is meant by regular-strand, Lang-strand, and reverse-strand wire ropes?**
5. **Why should greater care be taken when handling Lang-strand wire rope than when handling other rope?**
6. **What are the four requirements to consider in selecting wire rope?**
7. **What determines the strength of wire rope?**
8. **What is meant by the safety factor of wire rope?**

[11]

TYPES OF WIRE ROPE*

General Information

Wire-rope constructions are designated by the number of strands in the rope and the number of wires in each strand. Thus, a rope composed of six strands of seven wires to the strand is a 6 x 7 rope. Unless noted, or specified by the number of strands, the rope has a hemp center.

6 x 7 Standing-Rigging Rope

Ropes of 6 strands, 7 wires to the strand, and 1 hemp core, are known as "Haulage" rope, since the large outer wires are well suited to withstand the abrasive wear to which haulage ropes are subjected. This construction is the least flexible of the standard rope constructions. Wire centers are usually strands, making the rope construction 7 x 7.

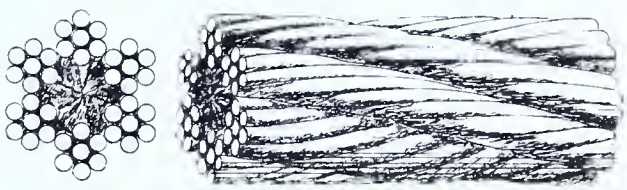


Fig. 89 — *Standing-Rigging Rope*

When fabricated of galvanized wires, covering a hemp core, it is termed a 6 x 7 Galvanized Guy Rope; and with a galvanized strand center, it becomes a 7 x 7 Galvanized Guy Rope.

6 x 19 Hoisting Cable

In the 6 x 19 hoisting cable the outer layer of wires in each strand consists of six large and six smaller wires. 6 x 19 Galvanized Guy Ropes are usually of Warrington construction, as shown in Fig. 90. The Warrington construction is used where severe service conditions exist.

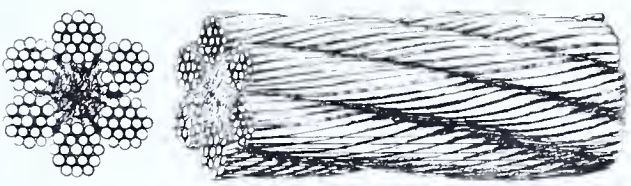


Fig. 90 — *Hoisting Cable*

*The source material for this information was furnished by the American Steel and Wire Company, and Rochester Ropes, Inc.

5 x 19 Marline-Clad Wire Rope

FIG. 91 — *Marline-Clad Wire Rope*

Each strand is served with a closely wrapped layer of tarred marline before it is closed into the completed rope. The marline forms a cushion for the strands, shields the strands against external wear as well as internal friction, and protects the hands of workmen handling the rope. The diameter of this type of rope is given for both before and after serving, eg., 3/8" before serving; 5/8" after serving. Expressed as 3/8" x 5/8" Marline-Clad Wire Rope.

6 x 24 — 7 Hemp Core — Galvanized Mooring Line

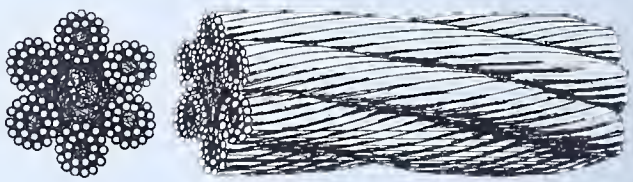


FIG. 92 — *Mooring and Hawser Lines*

This galvanized rope has 6 strands, each composed of two layers of wires, fifteen over nine, around a small hemp core. It is termed "Galvanized Hawser" and "Galvanized Mooring Line."

Table VIII

SAFE LOADS AND WEIGHTS OF WIRE ROPE*

Dia. in Inches	Approximate Weight Per Foot in Lbs.	Safe Load in Tons of 2000 lbs.		
		Cast Steel	Plow Steel	Improved Plow Steel
	6 x 7 Standing-Rigging Rope			
1/4	.094	.4	.47	
9/32	.12	.504	.59	
5/16	.15	.62	.73	
3/8	.21	.86	1.03	
7/16	.29	1.16	1.39	
1/2	.38	1.5	1.8	
9/16	.48	1.89	2.26	
5/8	.59	2.3	2.76	
3/4	.84	3.3	3.96	
7/8	1.15	4.48	5.36	
1	1.50	5.8	6.96	
1 1/8	1.90	7.28	8.72	
1 1/4	2.34	8.9	10.6	
1 3/8	2.84	10.6	12.5	
1 1/2	3.38	12.5	15.0	
	6 x 19 Hoisting Cable			
1/2	.40	1.5	1.82	2.1
9/16	.51	1.86	2.28	2.62
5/8	.63	2.28	2.8	3.22
3/4	.90	3.26	4.0	4.6
7/8	1.23	4.42	5.44	6.24
1	1.60	5.72	7.8	8.16
1 1/8	2.03	7.2	8.92	10.28
1 1/4	2.50	9.0	10.96	12.6
1 1/2	3.60	12.6	15.6	17.94
1 3/4	4.90	17.0	21.0	24.2
2	6.40	22.2	27.2	33.2
	5 x 19 Marline-Clad			
3/8 x 5/8	.34		1.6	
3/4 x 1	.88		4.0	
1 x 1 1/4	1.36		7.8	
1 1/4 x 1 1/2	1.97		10.96	
	6 x 24 Mooring and Hawser Lines			
3/4	.78	2.72	3.28	
1	1.38	4.74	5.70	
1 1/4	2.16	7.34	8.88	
1 1/2	3.11	10.52	12.72	
1 3/4	4.23	14.24	17.24	
2	5.52	18.40	22.40	

*The sizes and kinds of wire rope listed in this table are those most commonly used in the Sun Shipyard. Safety factor is 5 to 1. These safe loads referred to are for wires when used under ideal conditions.

‡The size referred to here means size before serving, as 3/8" dia., and size after serving, as 5/8", e.g., a wire rope is known as a 3/8" x 5/8" Marline-Clad, some times referred to as Durable Wire Rope.

The Findings of a Wire-Rope Test

A 7/8" wire-rope sling or pendant four feet long was put to a test of 104,100 pounds before it broke. By comparing these results with the tables of safe loads for wire rope, and using a safety factor, it may be easy to find out the quality of various makes of wire rope.

According to Table VI the minimum safety factor for slings is 8. Divide 104,100 lbs. by 8 and the answer will be approximately 13,000 lbs., or 6½ tons.

The safe load for a 7/8" diameter piece of 6 x 19 Plow Steel Hoisting Cable is approximately 6¼ tons; therefore the piece of wire rope tested will stand a safe load of 6¼ tons without question.

In Table VIII Safe Loads and Weights of Wire Rope, it will be seen that the safe loads for various pieces of 7/8" wire rope are as follows:

7/8" Diameter	Safe Loads in Tons		
	Cast Steel	Plow Steel	Improved Plow Steel
6 x 7 Standing-Rigging Rope.....	4.48	5.36	6.16
6 x 19 Hoisting Cable.....	4.42	5.44	6.24

Spring-lay Lines

Spring-lay wire ropes are manufactured in suitable sizes for mooring, towing and hauling lines, topping lifts, boatfalls, cargo falls, lifeboat falls and other varied uses.

Construction and General Characteristics

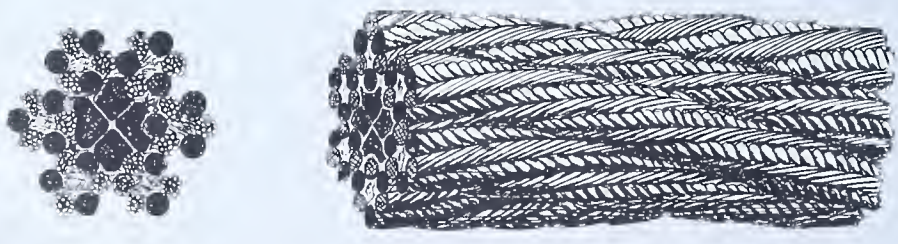


FIG. 93 — *Spring-lay Rope*

Spring-lay is composed of alternating strands of galvanized, improved-plow-steel wires and tarred hemp rope of the highest quality, closed in six major strands around a fiber core.

The function of the hemp parts is to provide a cushion for the wire strands, and the result is a rope of remarkable flexibility and elasticity, characteristics not heretofore found in ships' cables. To illustrate its flexibility, a 4¼" circumference spring-lay line of 56,000 lbs. breaking strain can easily be laid around a man's arm. For comparison, the strength of an 8" Manila hawser is 52,000 lbs.

The element of elasticity or "give" in spring-lay cable is likewise an innovation of the greatest importance. Being capable of a stretch of approximately six feet per hundred with corresponding backspring when the pull is released, it effectively absorbs the sudden jerks and stresses.

Drums, which are required in the handling of the old type of wire hawser, are not needed for spring-lay, inasmuch as the latter coils easily and lies flat like Manila, stowing in 40% of the space.

It handles perfectly on capstan and winch, and requires no more turns on a bit than do Manila lines. It is advisable not to use chain stoppers with this type of rope because of their cutting effect.

Table IX

SIZES OF SPRING-LAY ROPE COMPARED WITH MANILA ROPE

Circum. in Inches	Diam. in Inches	*B. S. in Pounds	Weight Per Ft. in Pounds	Manila Circum.	Manila *B. S.
1½	½	8,000	.22	2¾	7,700
2	⅝	12,500	.34	3½	12,000
2¼	¾	18,000	.49	4½	18,500
2¾	⅞	24,500	.63	5	22,500
3	1	30,000	.88	6	31,000
3½	1⅛	38,000	1.14	6½	36,000
4	1¼	47,000	1.36	7½	46,500
4¼	1⅜	56,000	1.66	8½	58,000
4⅝	1½	72,000	1.97	9½	71,000
5½	1¾	98,000	2.67	12	105,000

*Breaking strain. Take especial note that a safe working load is not given here.

ASSIGNMENT

Types of Wire Ropes

OBJECTIVE

To be able to recognize various types of wire rope used by riggers.

MATERIALS

Various pieces of the different types of wire rope used by riggers

Pencil and paper

PROCEDURE

1. Study the information on types of wire ropes.
2. Examine different types of wire rope and note the construction of each.
3. Label each piece examined as to which type of rope it is.
4. Note how the individual wires run in comparison to the strands.
5. On Table VIII find the safe load for a ½", 6 x 7 Cast-Steel, Standard-Rigging rope.

   A 1", 6 x 19 Plow-Steel, hoisting cable.

   A 1" x 1¼", 5 x 19, Marline-clad, wire rope.

   A 1½", 6 x 24, Mooring Line.
6. On Table IX find the safe load for a ¾" dia. Spring-lay rope. Use safety factor of 5 to 1.
7. Answer the following questions.

QUESTIONS

1. **When is guy rope termed 6 x 7, and when is it termed 7 x 7?**
2. **What is meant by Warrington construction?**
3. **What advantage is there in Marline-clad wire rope?**
4. **Why are Mooring and Hawser lines galvanized?**
5. **What is Spring-lay rope?**
6. **What is the best field of service for Spring-lay rope?**

[12]
CARE OF WIRE ROPE*

Lubricating Wire Rope

The importance of periodical lubrication is apparent from the fact that a wire rope is a machine with many moving parts. Each time a rope bends or straightens, the wires in the strands and the strands in the rope must slide on each other. This friction requires a film of lubricant on each moving part.

A second important reason for lubricating iron-wire and steel-wire ropes is to prevent corrosion of the wires and deterioration of the hemp center. There is no known means of inspection which will even approximate the strength of a corroded rope. A rusty rope is a liability.

Used ropes should be cleaned before they are lubricated. The cleaning may be accomplished by means of wire brushes or scrapers, by compressed air, or by superheated steam. The object is to remove all foreign material and old lubricant from the valleys between the strands and from the spaces between the outer wires. The lubricant may be applied in any manner suitable to field conditions. It may be brushed onto the rope with a stiff brush; applied by passing the rope through saturated waste; by passing the rope through a trough or box of lubricant; or the lubricant may drip onto the rope, preferably at a point where the rope opens slightly from bending. The object is to apply a uniform coating to the entire length of rope.

When a wire rope is taken out of service for an appreciable length of time, it should be cleaned and lubricated. It should be stored in a dry place protected from the elements.

The internal parts of wire rope move one against another whenever the rope passes over a sheave or winds on a drum. Each wire rotates around its own axis and all wires minutely slide by each other.

During the manufacture of wire rope the hemp center and strands are thoroughly impregnated with a type of lubricant that will satisfactorily pro-

*The source material for this information was furnished by the American Steel and Wire Company, John A. Roebling's Sons Company, and Wickwire Spencer Steel Company.

tect and lubricate it in service for as long a period of time as possible. During operation, however, several factors combine to render this lubricant ineffective. The pressures encountered during operation over sheaves tend to force the lubricant to the surface where it combines with dirt and other foreign material and loses its lubricating value. Heat and dryness have a decided effect, and of course the magnitude of the loads handled and frequency of operation enter the picture as well.

If the lubricant thus lost is not replaced, the wires and strands are subject to unnecessary friction during operation over sheaves, and this hastens the development of fatigue. Many times a rope will show no outward evidence of this form of abuse, but a few applications of lubricant would have added many miles of service. In some cases the friction between individual parts becomes so severe that the results are clearly in evidence when the rope is taken apart and examined. In such cases, lubrication again would most certainly have improved the life of the rope, and prevented deterioration of a type which is accumulative in detracting from the rope's strength and safety.

Loss of lubricant also tends to increase the rate of wear between the rope and the equipment over which it operates. Sheave grooves can usually be kept in a better condition by maintaining proper lubrication, and this is a factor which has become of much greater significance as heavier loads have been developed. It is primarily for this reason that many users of wire rope follow a regular lubricating practice and find it well worth the time and slight additional expense involved.

When corrosive conditions are present, lubrication is a necessity. Only by preventing the development of corrosion can the tables of safe loads, or any other known method of estimating remaining strength, be used with reliability.

Lubricant lost during operation can be satisfactorily replenished by external application, and if the proper type and quantity is put on at each application, no difficulty should be experienced with the material running down the ropes or being thrown off in the machine room and causing slippage troubles. Such a lubricant should be thin enough to penetrate to the center of the rope, and it should be sufficiently tenacious not to throw off. It should, of course, contain no ingredients harmful to wire rope. There are several compounds on the market that fulfill these requirements, and if applications are made in the proper amounts entirely satisfactory results will be obtained.

The lubricant can be applied with a device designed to do the work more quickly and more effectively than can be accomplished by hand. One such device consists merely of a hinged box with two containers, into which holes are drilled near the bottom for dispensing the lubricant to the ropes. Brushes are placed below the containers to spread the lubricant and work it into the valleys between the strands. As the ropes run through this box, lubricant is poured into the containers, and a complete application can be made in very little time.

The size of the holes in the container, and the speed at which the ropes are operated, should be such that approximately one quart of lubricant, or a little more, is applied to each 600 feet of $\frac{5}{8}$" diameter ropes. For $\frac{1}{2}$" diameter ropes this quantity should be applied to each 900 feet of rope.

If the lubricant is painted on the ropes with a brush, application at the point where they operate over the drive sheave is most effective. Sometimes when this work is done by hand, there is a tendency to spread the material too thin. If so little is applied that it does not penetrate to the hemp center, much of the value of the application will be lost. It is important that a sufficient quantity be used.

Lubricating Compound

The compound for lubricating wire rope used at the Sun Shipyard consists of the following:

For summer use:

15 gallons of gear compound

20 gallons of Delaware winter crankcase oil.

1½ gallons of apexior

Apexior is an asphalt base, inflammable, slow-drying, water-resisting paint.

For winter use:

7 gallons of gear compound

30 gallons of Delaware winter crankcase oil

1 gallon of apexior

Exchange the Ends

Frequently, in the normal use of wire ropes, the most severe deterioration, due to close bending, occurs near one of the ends. The life of a length of rope so damaged may be materially increased by exchanging the drum end with the load end, thus reversing the rope in use. At the same time, worn sections in the remainder of the length will also be relocated and perfect sections exposed to the positions of greatest wear.

Turning ropes end for end has frequently resulted in service increases as high as 25%.

Common Causes of Wire-Rope Failures

Of the many forms of abuse of wire ropes, the most commonly encountered are:

Ropes of incorrect size, construction, or grade.

Ropes allowed to drag over obstacles.

Ropes not properly lubricated.

Ropes operated over sheaves and drums of inadequate size.

Ropes allowed to overwind or crosswind on drums.

Ropes operated over sheaves and drums with improperly fitting groove or broken flanges.

Ropes permitted to jump sheaves.

Ropes subjected to moisture or acid fumes.

Ropes with improperly attached fittings.

Ropes permitted to untwist.

Ropes subjected to excessive heat.

Ropes kinked.

Ropes subjected to severe overloads.

Ropes destroyed by internal wear caused by grit penetrating betwee strands and wires.

Unreeling and Uncoiling

When removing wire rope from the reel on which it is received, or from the coil if it is a coil shipment, it is imperative that the reel or coil rotates as the rope unwinds. Attempts to unwind rope from stationary coils or reels will result in kinking the rope; once a kink is formed, the rope at that point is ruined beyond repair.

Unreeling

There are several correct methods of unreeling rope.

METHOD 1. The reel may be mounted on a shaft supported by two jacks as shown in Fig. 94. The rope is then pulled from the reel by a workman holding the end of the rope and walking away from the reel, which rotates as the rope unwinds. This is the common, approved method of unreeling wire rope.

METHOD 2. The reel may be mounted on an unreeling stand as shown in Fig. 95. It is then unwound in the same manner as described above. Care must be exercised to keep the rope under sufficient tension to prevent slack rope's accumulating and dropping below the lower reel head.

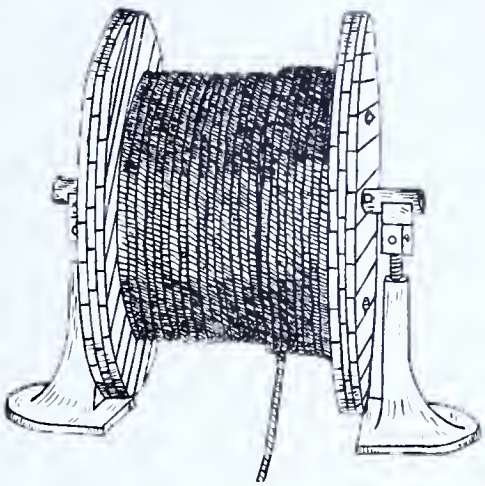


FIG. 94

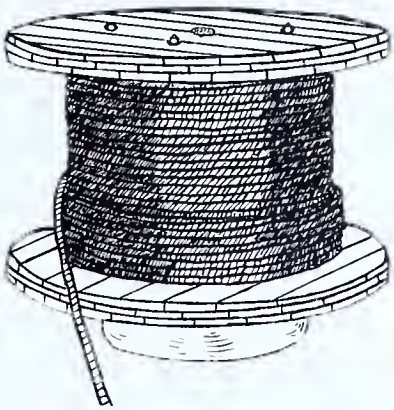


FIG. 95

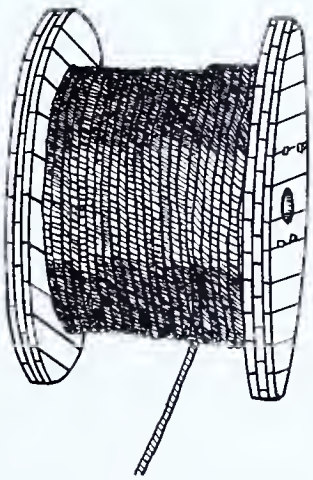


FIG. 96

METHOD 3. The end of the rope may be held and the reel rolled along the ground as shown in Fig. 96.

When rope is re-reeled from one horizontal reel to a second horizontal reel, the rope should travel from the top of the full reel to the top of the empty reel; or, from the bottom of the full reel to the bottom of the empty reel.

Avoid putting a reverse bend into the rope as it is being re-reeled. Reeling the rope so that a reverse bend is put into it causes it to become "livelier" and harder to handle.

METHOD 4. Pass a chain through the center of the spool, and insert an iron rod through the bottom end of the chain. The coil is then lifted with a chain hoist sufficiently high to let the drum rotate. As soon as enough wire is uncoiled, the drum is lowered to keep the wire from further unwinding. Fig. 97.

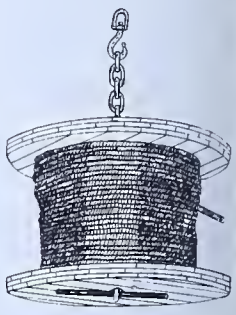


FIG. 97

Uncoiling

If the rope is to be unwound from a coil, there is only one correct method of uncoiling. The end of the rope should be held and the coil rolled on the ground like a hoop, as shown in Fig. 98.

Failure to use one of these methods has ruined many a length of wire rope. Hemp rope can be unwound by pulling through the eye of the coil or from the stationary reel standing on end without seriously injuring it. These methods should never be attempted when one is handling wire rope.

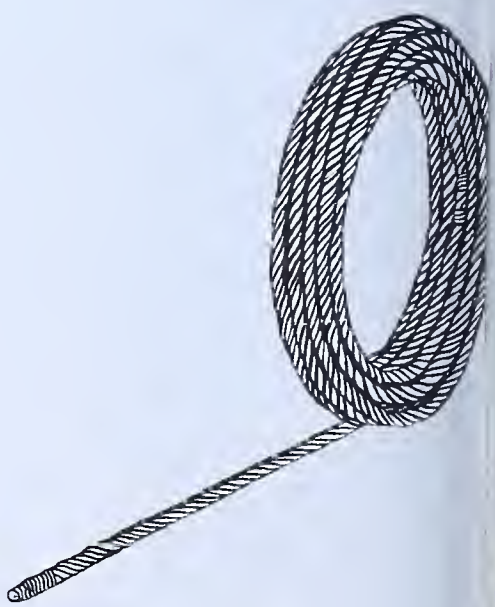


FIG. 98

Spooling and Coiling

Correct Method of Winding First Layer on Drum

When the first layer of wire rope is being wound on a smooth drum, it should be started from the side which causes the coil on the drum to hug together. This procedure tends to produce a uniform and closely-wound first layer, which, in turn, tends toward uniformity of successive layers. It also results in an even wind of the coil of the first layer on the drum when the rope is re-wound after the load has been slacked off and then picked up.

When the first layer of wire rope is wound on a smooth drum in the wrong direction, the coils tend to spread apart. Coils of the second layer wedge themselves between the open coil and cause non-uniform winding, which may result in damaging the rope from crushing and abrasion. There is also a tendency, when the rope is out and the load slacked off and then applied again, for the remaining coils on the drum to cross other coils, with resultant crushing of the rope at the points of crossover.

The proper direction of winding the first layer on a smooth drum is determined by standing behind the drum and looking along the path the rope travels.

Right-lay Wire Ropes	Overwind:	From Left to Right
	Underwind:	From Right to Left
Left-lay Wire Ropes	Overwind:	From Right to Left
	Underwind:	From Left to Right

When the operator is overwinding, the top of the drum rotates toward the observer while the rope is winding on. When the operator is underwinding, the top of the drum rotates away from the observer while the rope is winding on.

Correct Method of Coiling Wire Rope

When hand coiling wire rope into a coil on the floor or on a bench, coil it in the direction that will take twist out of the rope. When it is coiled in the proper direction, little difficulty will be encountered; but if it is coiled in the wrong direction, twists are added and the rope becomes too lively to form into a coil readily.

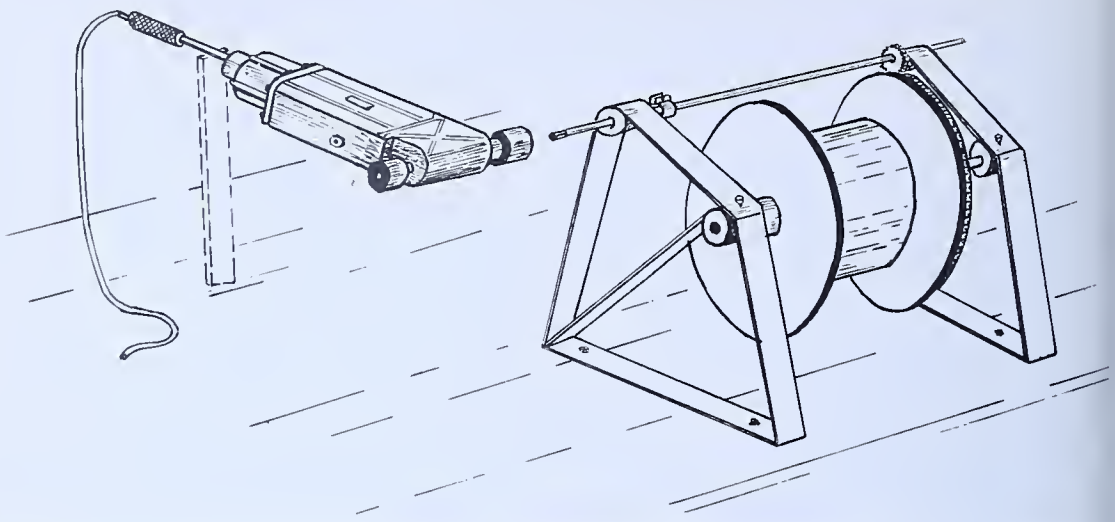


FIG. 99 — *A corner machine which operates with compressed air. It is used to turn the hawser reel drum in either direction, simply by changing the corner machine to the opposite end of the shaft. Some of the newer types can be reversed simply by moving a lever.*

ASSIGNMENTS

Cleaning and Lubricating Wire Rope

OBJECTIVE

To learn how to prolong the life of wire rope.

TOOLS AND MATERIALS

A small coil of dirty wire rope
Wire brushes and scrapers
A suitable lubricant
Waste
A stiff brush

PROCEDURE

1. Clean the wire by removing all foreign material and old lubricant from the valleys between the strands and from the spaces between the outer wires.
2. Apply the lubricant with a stiff brush, or pass the rope through saturated waste.
3. Apply a uniform coating of lubricant to the entire length of the rope.
4. Write the answers to the following questions.

QUESTIONS

1. **Why should wire rope be lubricated?**
2. **Why should wire ropes be cleaned before they are lubricated?**
3. **What are the four methods of lubricating wire rope?**
4. **In what kind of a place should wire rope be stored?**
5. **What does continued service of a fiber-cored wire rope do to the fiber?**
6. **Why should the ends of wire rope be changed?**
7. **Give five common causes of wire-rope failures.**

Spooling and Coiling Wire Rope

Objective

To learn correct methods of handling wire rope.

Tools and Materials

A drum partly filled with wire rope

A coiling rack

Procedure

1. Weight down the end of the wire rope, or have some one hold it.
2. Roll the drum across the floor until all of the wire is off the drum. Be very careful that no kinks develop.
3. Place the drum in a coiling rack.
4. Wind the first layer on the drum very smoothly. Start from the side which causes the coils on the drum to hug together.

   Keep the coils very tight and close together, and make sure that the wire is wound in the right direction.
5. Remember that left-lay wire ropes are wound just the opposite to right-lay wire ropes.
6. Answer the following questions.

QUESTIONS

1. **Why should the first layer of wire rope to be wound on a drum be started from a certain side?**
2. **What happens if the first layer is wound in the wrong direction?**
3. **What is the proper direction for winding the first layer of right-lay wire ropes on a smooth drum? the first layer of left-lay ropes?**
4. **Which way does the drum rotate when the rope is being overwound? When underwound?**

Coiling Wire Rope By Hand

OBJECTIVE

To learn correct methods of handling wire rope.

TOOLS AND MATERIALS

A coil of wire rope

PROCEDURE

1. Coil the rope on the floor in the direction that will take the twist out of the rope.
2. Answer the following question.

QUESTION

1. **What happens if a wire rope is coiled in the wrong direction?**

Seizing Wire Rope

GENERAL INFORMATION

Before cutting a wire rope, the rigger should wrap a seizing on each side of the spot where the rope is to be cut, to prevent unlaying or loss of lay or pitch of the strands.

A Lang-strand rope, a rope containing an independent wire-rope core or a wire-strand core, or a non-spinning rope of 6 x 19 construction should have not less than four seizings on each side of the point of cut. Other ropes should have not less than three seizings on each side. It is always advisable to hold a complete length of rope lay within the applied seizings.

Annealed iron wire should be wound tightly in a close helix around the rope. Note the following tabulation of approximate wire sizes, lengths per individual seizing to be used, and the method of applying the seizing.

Table X

SEIZINGS RECOMMENDED

Rope Dia. in Inches	Number of Seizings		Length of Seizings in Inches	Distance Between Seizings in Inches	Approx. Size of Seizing Wire in inches
	Regular-Strand Hemp-Center Ropes	18 x 7 Non-Spinning; Lang-Strand; and Wire-Center Ropes			
½ and Smaller	2	3	½	1	.020 - .030
9/16 - ⅞	3	3	1	2	.040 - .060
1 - 1¼	3	4	1½	2	.060 - .090
1⅜ - 1⅝	4	4	2	2	.080 - .125
1¾ - 2	4	4	3	2	.105 - .125
2⅛ and Larger	4	4	4	3	.105 - .125

Method A

TOOLS AND MATERIALS

A seizing iron
Nippers
Seizing wire

PROCEDURE

1. Lay one end of the seizing wire in the groove between two strands of the wire rope as shown in Fig. 100.

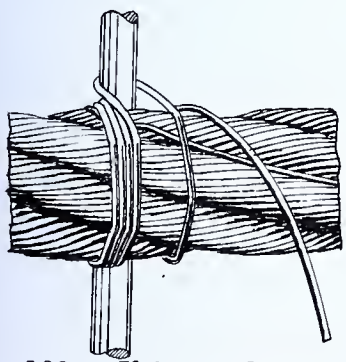


FIG. 100 — *Using a Seizing Iron*

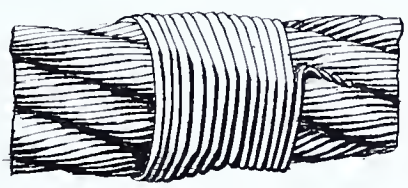


FIG. 101 — *The Completed Seizing*

2. Wrap the other end tightly in a close helix over the portion in the groove with a seizing iron. (See Fig. 100). The width of the seizing should be equal to the diameter of the rope or wider.

3. Twist both ends of the seizing wire tightly together.

4. Cut off the ends of the wire and lay the twisted ends into the groove of the rope. (See Fig. 101).

How to Wrap a Seizing on a Wire Rope
Method B

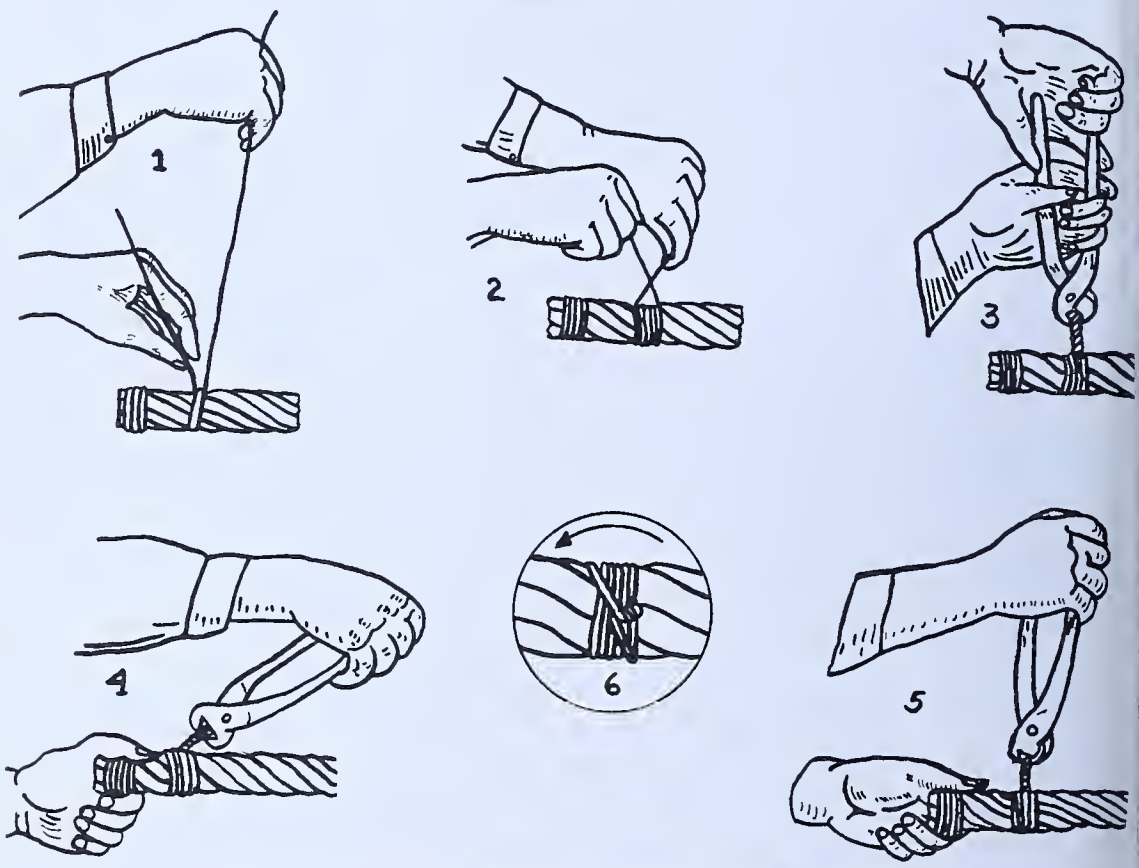


FIG. 102 — *How to Wrap a Seizing on a Wire Rope*

PROCEDURE

1. Wrap the seizing wire in a close helix around the wire rope as tightly as possible.

2. Twist the ends of the seizing together by hand counter-clockwise so that the twist is near the middle of the seizing.

3. Using "Carew" cutters, tighten the twist just enough to take up the slack. Do not try to tighten the seizing by twisting.

4. Tighten the seizing by prying the twist away from the axis of the wire rope with cutters.

5. Tighten the twist again as in 3. Repeat 4 and 5 as often as is necessary to make the seizing tight. Cut off the ends of the wires, and pound the twist into contact with the seizing.

6. Compare your work with the appearance of the finished seizing.

Cutting Wire Rope

Wire rope may be cut with a cold cutter or with a hydraulic cutter. Naturally a much cleaner cut can be made with the hydraulic cutter; however, at times while out on the job away from a cutter, it becomes necessary to resort to the best method available.

FIG. 103 — *The above illustration shows a large piece of wire rope about to be cut with the hydraulic cutter. Note the seizings on each side of the spot where the rope is to be cut.*

ASSIGNMENT

Seizing Wire Rope

OBJECTIVE

To learn how to seize wire rope.

TOOLS AND MATERIALS

Several pieces of wire rope (different sizes)

Suitable sizes of seizing wire

Carew cutter

A wire-rope vise

PROCEDURE

1. Follow the procedure shown in the information sheet.
2. Make the width of the seizing not less than the diameter of the wire rope.
3. Write the answers to the following questions.

QUESTIONS

1. **Why should wire ropes be seized?**
2. **What size of seizing wire should be used for a ½″ wire rope?**
3. **How should a seizing be tightened?**

[13]
SHEAVES*

How to Inspect Sheaves Used with Wire Rope

Proper inspection of wire rope must necessarily include examination of the equipment on which it is being used. In the majority of instances the cause of abnormal deterioration of wire rope is to be found in the machinery on which it is operating.

The principal items to be checked are:

1. Sheaves
2. Drums
3. Reeving
4. General operating conditions

Sheaves

Points to be checked on sheaves are:

1. Size. Measure the diameter of a sheave from bearing surface to bearing surface, not from flange edge to flange edge, because it is the radius of the bearing surface that governs the degree of bending to which the rope is subjected as it travels over the sheave. Table XI gives the recommended and the minimum sheave diameters for various constructions of rope. (These recommendations apply to drums as well as sheaves.)

Since the rate of fatigue of wire rope is governed very largely by the radii of the bends which it must take in normal operation, it is extremely important that the recommended diameters be equaled or exceeded. A large amount of internal wear is caused by improper sheave (and drum) diameters, since the radial pressure on a wire rope increases in inverse proportion to the radius of the bend. As the radial pressure increases, there takes place in the rope a crushing action which increases internal friction and causes nicking of one inside wire by another.

*The material for this information sheet was written by A. J. Morgan, Chief Engineer, Wire Rope and Strand Division of John A. Roebling's Sons Company, Trenton, N. J., and is reproduced by permission.

2. Sheave Grooves. The diameter of the bearing grooves of sheaves (and drums) must bear a certain definite relation to the diameter of the wire rope used in it. See Fig. 104. As a rope passes constantly over the sheave, the groove is worn deeper and the rope diameter becomes constantly smaller until it is less than that of a new rope of listed diameter. When a new rope is placed in such a groove it will be forced down into the groove and pinched out of shape. Hence it will be subjected to extreme conditions of abrasion against the sides of the groove. Also, it will be forced out-of-round and therefore will become unbalanced.

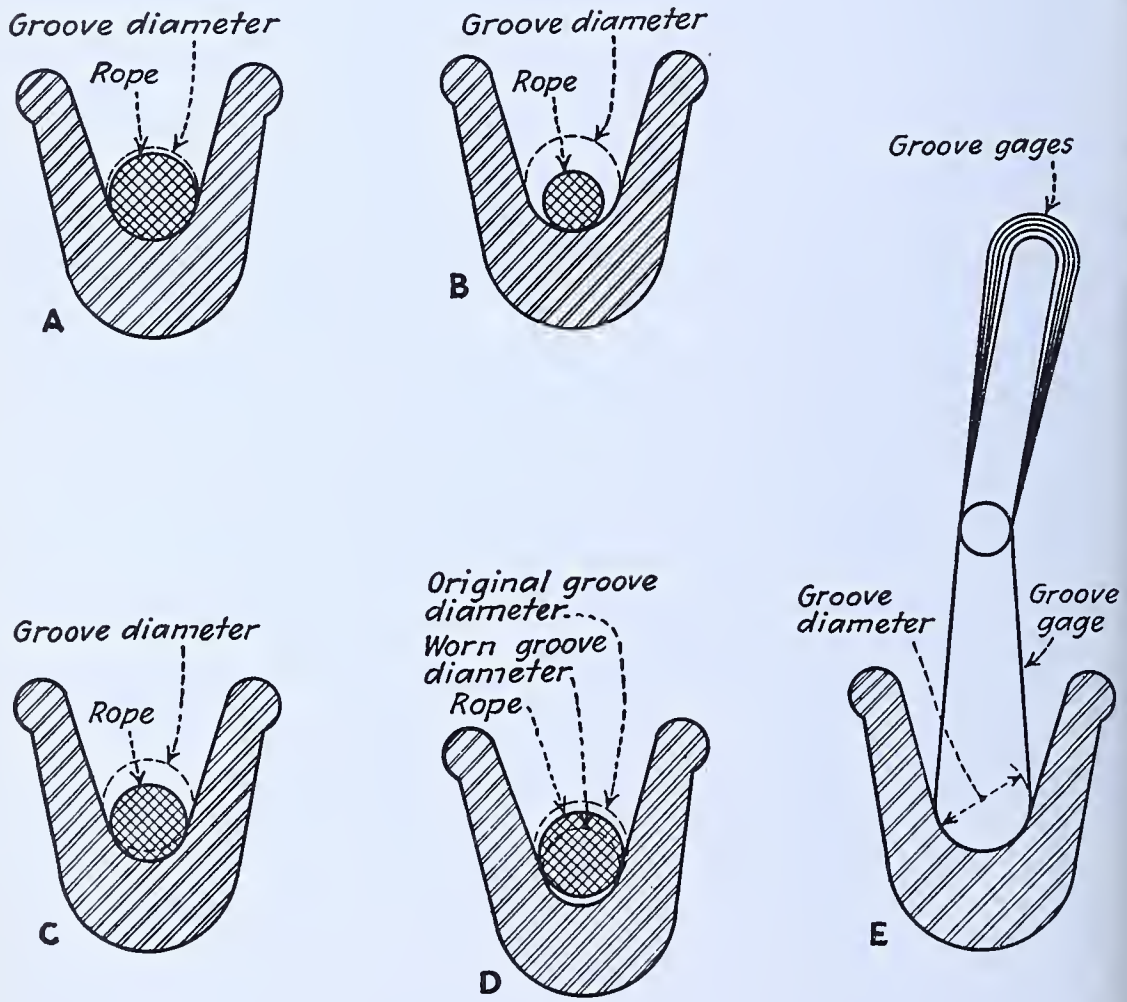


FIG. 104 — *Grooves should support a wire rope for nearly one-half its circumference, as in A. When a groove is too large, B, the rope tends to flatten under tension. The groove in C has worn to the decreased diameter of the rope. A new rope in a worn groove, D, will be inadequately supported. Use a groove gauge, E, to check grooves.*

Table XI

RECOMMENDED AND MINIMUM DIAMETERS FOR SHEAVES

Rope	Recommended Diameter No. Times Rope Diameter	Minimum Diameter No. Times Rope Diameter
6 x 7	72	42
6 x 19	45	30
6 x 30	45	30
6 x 37	27	18
8 x 19	31	21
18 x	51	34

On the other hand, a rope placed in a sheave groove of too great a diameter will not be afforded proper support. Such a condition tends to allow the rope to flatten out as radial pressure is applied to it.

The ideal condition is that in which the wire rope receives support from the sheave groove around just less than one-half of its circumference. The rope is thus allowed freedom of action with a maximum of support. Gauges for measuring sheave grooves can be obtained from any wire-rope manufacturer.

Table XII gives the tolerances recommended for sheave grooves.

Table XII

TOLERANCE BY WHICH SHEAVE-GROOVE DIAMETER SHOULD EXCEED ROPE DIAMETER

Nominal Rope Diameter, Inches	Recommended Tolerance, Inches
1/4—5/16	1/64
3/8—3/4	1/32
13/16—1-1/8	3/64
1-3/16—1-1/2	1/16
1-9/16—2-1/4	3/32
2-5/16 and larger	1/8

3. Sheave Materials. Sheaves of a material that is too soft will be cut by wire rope, and their bearing surfaces will become corrugated to fit the contour

of the rope used over them. This contour will not exactly conform to that of the next rope to be used over them; therefore the new rope will be cut and worn by the corrugations. Where such a condition prevails the sheaves should be re-machined or, preferably, replaced with sheaves of harder material.

Such corrugation will occur more readily if the sheave diameter is too small.

4. Sheave Operation. Defective bearings will cause sheaves to wobble or to revolve eccentrically and will thus set up a whipping action in the wire rope. Whipping will, of course, greatly increase the rate of fatigue and other deterioration of the rope. Such a condition should be corrected immediately.

5. General Sheave Conditions. A sheave that is out-of-round or has a flat spot on its bearing surface will also cause whipping of the rope; such a condition must be repaired immediately. Sheave grooves should be either machined or ground until both surface and contour are smooth and true.

When a sheave flange is broken off the wire rope may jump this flange and cause serious damage both to the rope itself and to the machinery. If the rope does not jump the flange, it is at least likely to come in contact with the sharp edges of the broken flange and become badly gouged. Such sheaves should be replaced without delay.

ASSIGNMENT

Gauging Sheaves and Selecting Wire Rope for Them

OBJECTIVE

To learn how to prolong the life of wire rope.

TOOLS AND MATERIALS

Several sizes of hoisting wire

Several sizes of sheaves

A groove gauge

A slide gauge

PROCEDURE

1. Study the information given on sheaves and grooves.
2. Gauge each of the sheaves.
3. From Table XI (Minimum Diameters for Sheaves) select the proper size of wire rope for each sheave.
4. Gauge the different pieces of hoisting wire with a slide gauge.
5. Write the answers to the following questions.

QUESTIONS

1. **What is the result of using sheaves that are too small for the wire rope used?**
2. **How will the size of the sheave prolong the life of a wire rope?**
3. **Determine the sizes of wire rope that should be used to fit the diameters of the sheaves that you gauged.**

[14]

SPLICING WIRE ROPE*

How to Splice a 6-Strand Wire Rope

General Information

When a wire rope is spliced endless, or two similar ropes are spliced together, a short length of each of the two ends is consumed in making the splice. This should be considered when ordering the lengths to be spliced.

There are two endless splices: the Standard Short Splice, used for splicing most six-strand ropes; and the Long Splice, used for splicing haulage ropes and long lengths of wire rope operating under heavy loads. The Long Splice differs from the Standard Short Splice in that the distance between tucks and length of tuck is greater and more rope is required in making the splice. Otherwise the two methods are the same.

Table XIII

AMOUNT OF ROPE TO ALLOW FOR MAKING ENDLESS SPLICES

Diameter of Wire Rope in Inches		¼ to ⅜	½ to ⅝	¾ to ⅞	1 to 1⅛	1¼ to 1⅜	1½
Length of Rope to Allow in Feet	Standard Short Splice	15	20	24	28	32	36
	Long Splice	30	40	50	60	70	80

Procedure

1. On each of the two rope ends to be spliced, place a seizing at a distance from the end equal to half the allowance for splicing. As an example, if two lengths of ½-inch-diameter rope are to be spliced by the Standard Short Splice, the seizings would be placed ten feet from the ends.
2. Unlay the strands of each of these seizings as shown in Fig. 105.

*This information was adapted from material furnished by the American Steel and Wire Company.

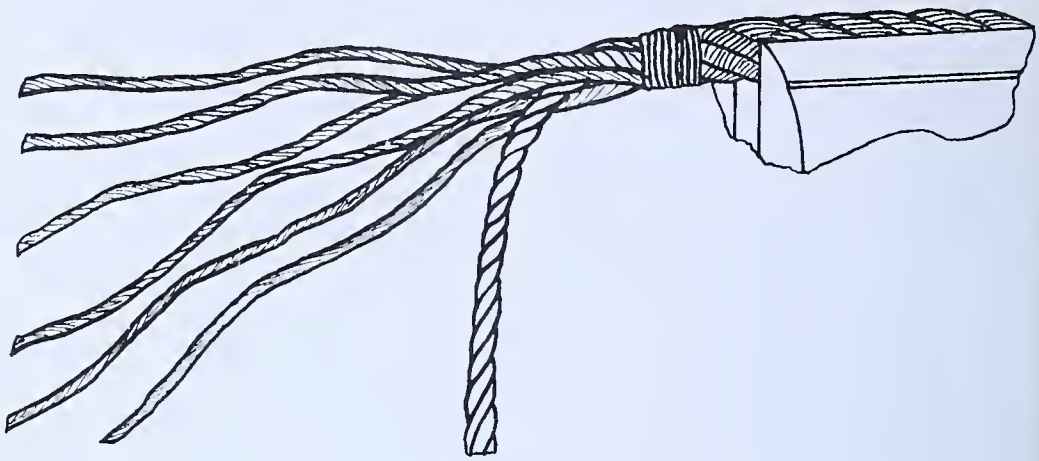


Fig. 105

3. Cut off the hemp centers as near the seizings as possible.

4. Interlock the six strands of each end in a finger-lock position. Force the ends together so that the seizings are as near each other as possible. Remove the seizings. See Fig. 106.

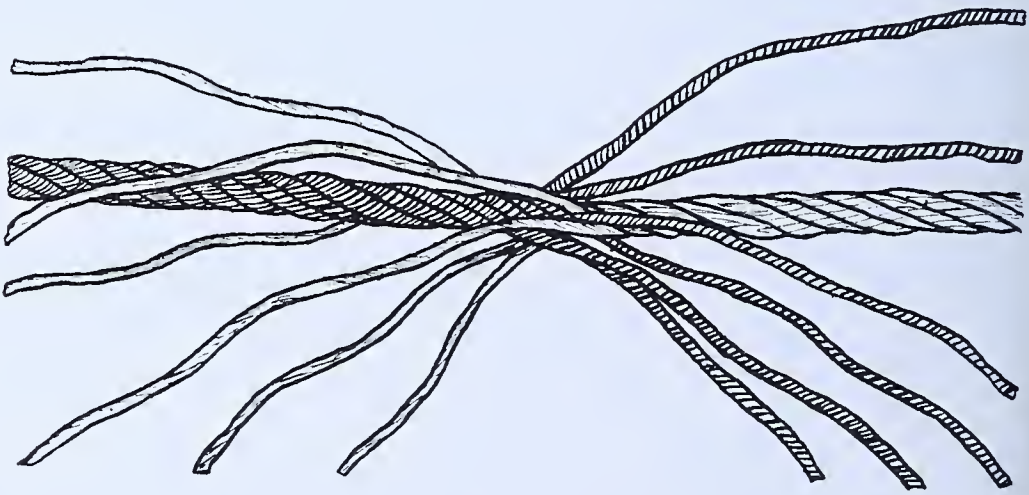


Fig. 106

5. Unlay one strand, filling the groove vacated by this strand with a strand from the other rope end. Figure 107 shows the first strand from each rope end being replaced by a strand from the other rope end.

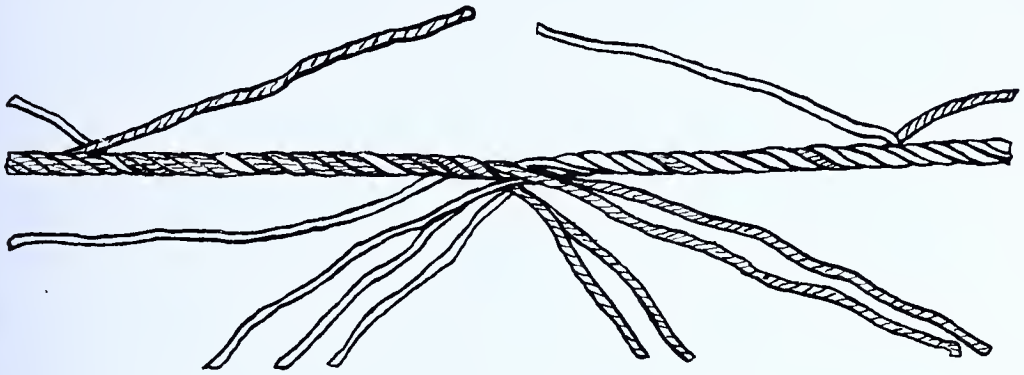


FIG. 107

This process should be continued with each strand from each rope end until only one strand equal to the length of the tuck remains. The remaining strand is tucked at the point where the splice was started.

The length of tuck is approximately one twelfth of the amount of rope allowed for the splice.

Table XIV

LENGTH OF TUCK IN INCHES

Diameter of Rope in Inches		¼ to ⅜	½ to ⅝	¾ to ⅞	1 to 1⅛	1¼ to 1⅜	1½
Length of Tuck in Inches	Standard Short Splice	15	20	24	28	32	36
	Long Splice	30	40	50	60	70	80

5. Unlay the second strand from each rope end and replace it by a strand from the other rope end in the same manner, but stop at a distance twice the length the tuck from the point where the first pair of strands protrude. In a similar manner, the third strand from each end should be replaced by a strand from the other end for a distance equal to the length of the tuck.

The twelve strands now protrude from the rope in pairs at points separated by twice the length of the tuck.

7. Cut off the protruding strand ends leaving lengths equal to the length of the tuck. Figure 108 shows two of the six pairs of strand ends.

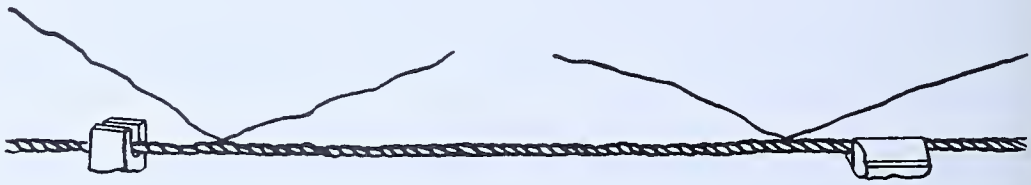


Fig. 108

The strand ends of preformed wire ropes should be straightened. It is not necessary to straighten the strand ends of non-preformed ropes. With this exception the method of splicing is the same for both.

8. Wrap the strand ends with friction tape or twine. A layer of tape or twine helps to hold the tucked ends in place as it makes them larger in diameter and increases the binding action of the outer strands. It is advisable to build up the diameter of the strand ends with tape or twine as much as possible without making the rope oversize when the strand ends are tucked.

The method of tucking the six pairs of strand ends is the same for each pair.

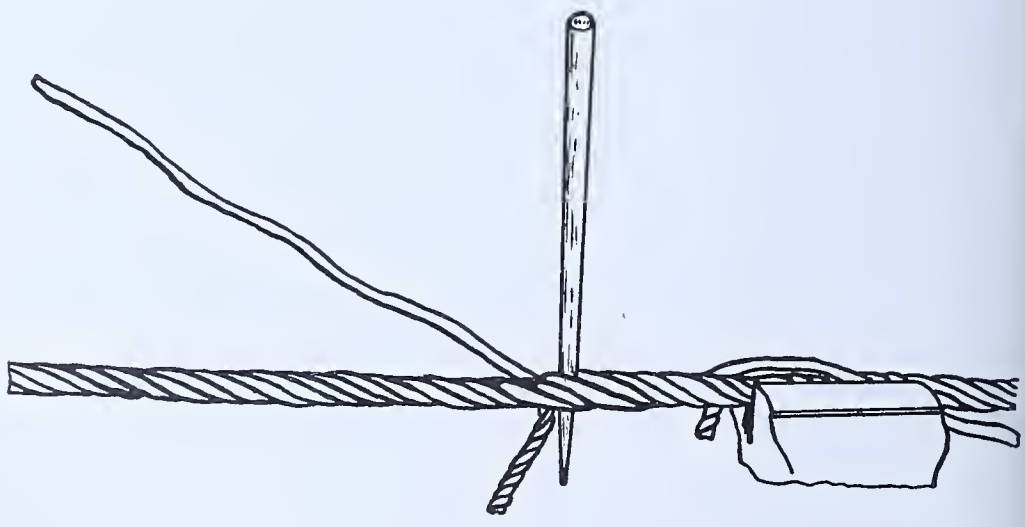


Fig. 109

If a vise is available, it should be used to facilitate the tucking operation. If a vise cannot be obtained a Manila-rope sling and a short wooden lever may be used to untwist and open the rope.

9. Place the rope in the vise so that the vise grips the rope and one of the two strand ends just beyond the point where a pair of strand ends protrudes from the rope. See Fig. 109.

10. Drive the marline spike under three strands, opening the wire so that the hemp center may be cut and the end pulled through the opening made by the point of the marline spike.

11. Start the wrapped strand end into the space left vacant by the removal of the hemp center; then rotate the marline spike so as to force out the hemp center and force the strand end into the center of the rope.

    By rotating the spike, the strand end is tucked its entire length. See Fig. 110.

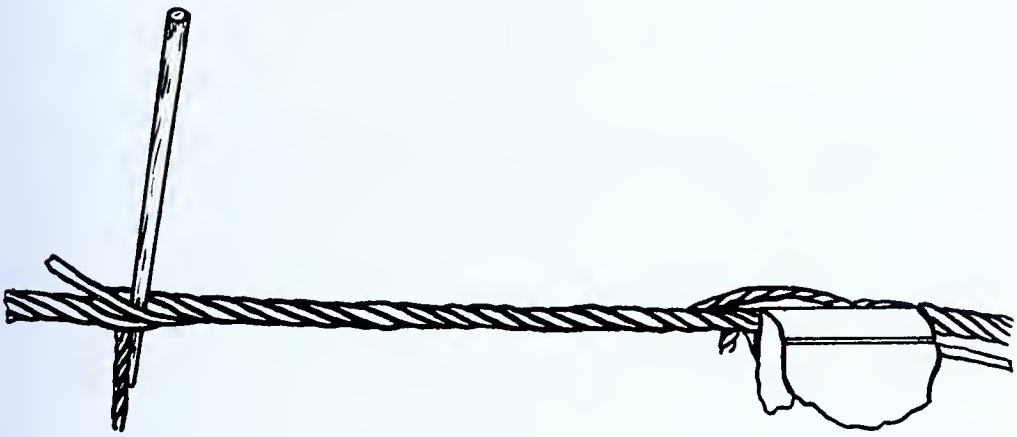


Fig. 110

12. Regrip the rope in the vise so that the second end can be tucked. See Fig. 111.

13. Drive the marline spike under three strands as before and force the strand into its proper position with a pair of splicing tongs or some other form of clamp, taking pains not to have any slack in the strand. See Fig. 111.

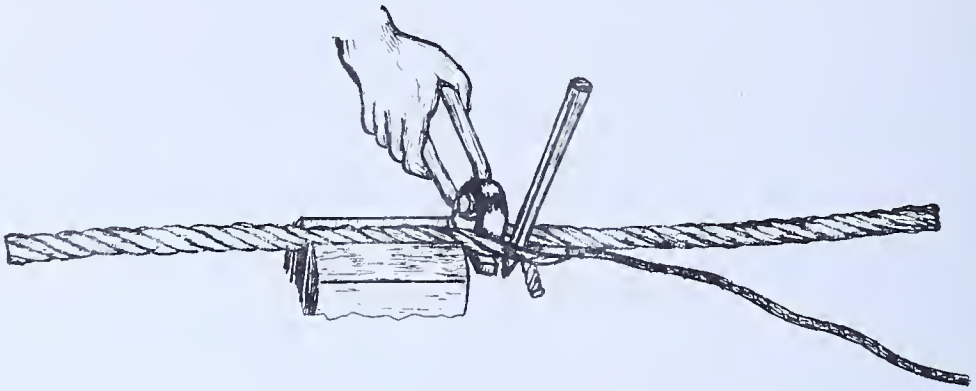


FIG. 111

14. Rotate the marline spike, forcing the hemp center from the rope and forcing the wrapped strand end into the space vacated by the hemp center. The strand end is tucked its entire length in this manner.

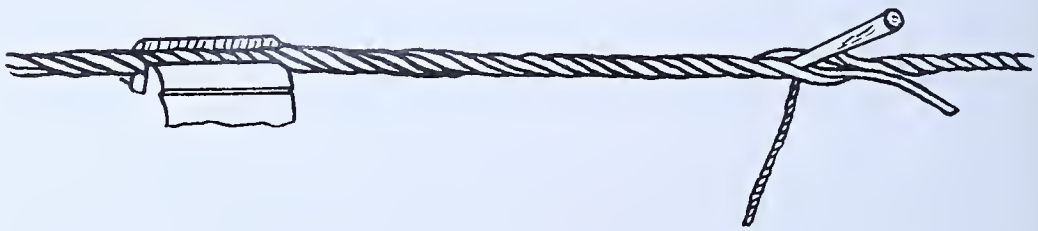


FIG. 112

When regular-lay ropes are spliced, the strand ends should not cross at the point where the tucks begin. See Figs. 112, 113, 114.

When Lang-strand ropes are spliced, it is advisable to have the strand ends cross at the points where the tucks begin, as this increases the holding power of the splice. This is accomplished by inserting the marline spike under the strand end which was tucked when starting the tucking operation on the second strand end.

The rope will be somewhat deformed at the point where the tucks start. This deformity can be corrected by hammering the rope at this point with wooden mallets. See Fig. 113.

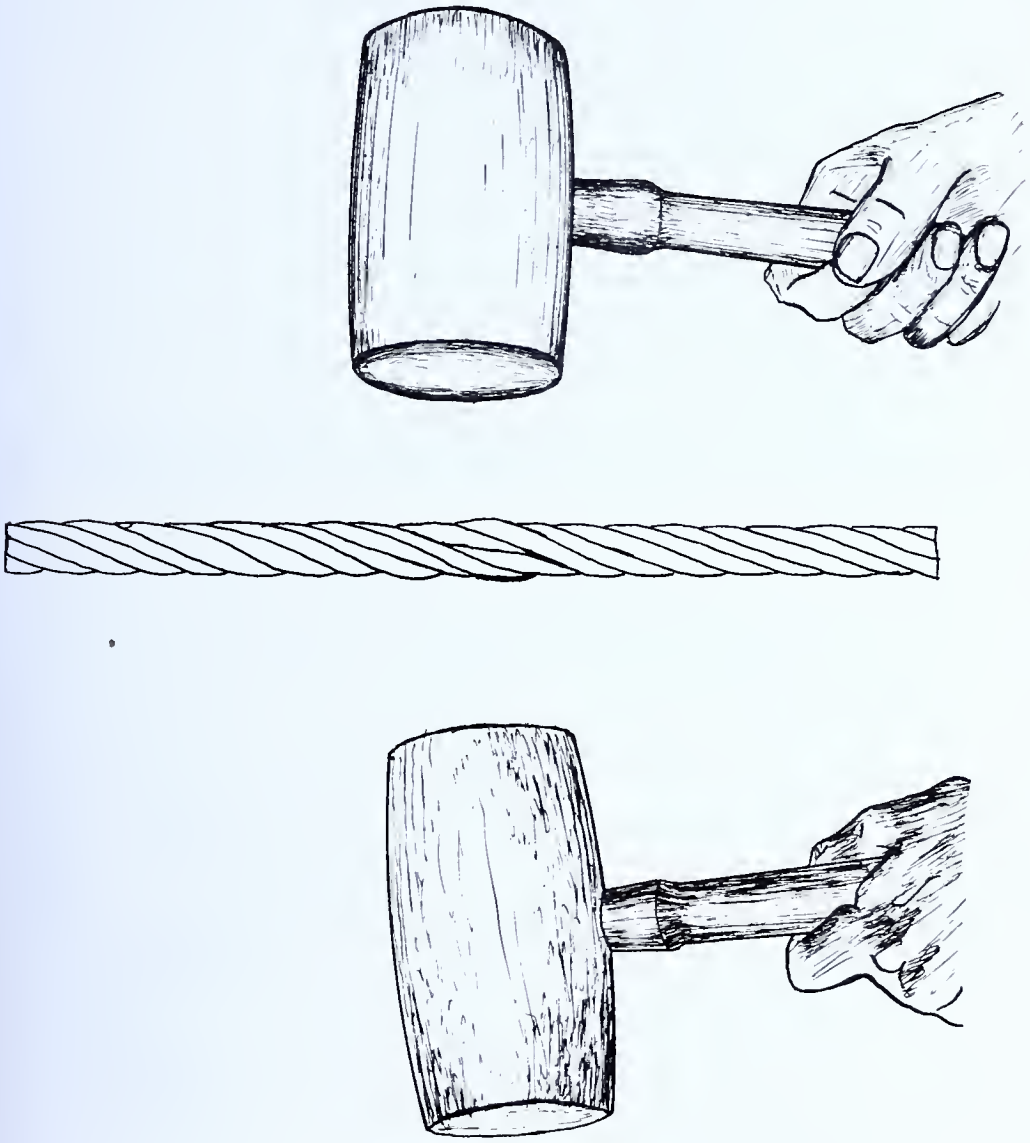


FIG. 113

Figure 114 shows one of six similar points of the finished splice where one pair of tucked strands starts. A rope spliced in this manner is nearly as strong as the original rope. After being used a few days, a well-made splice can be detected only by a careful examination of the rope.

Fig. 114

ASSIGNMENT

Splicing a 6-Strand Wire Rope
(The Standard Short Splice)

Objective

To learn how to splice wire ropes.

Tools and Materials

A wire-rope vise
A 6-strand wire rope of sufficient size and length to make a sling
Carew cutter
A jackknife
A Manila-rope sling
A short wooden lever
Friction tape or twine
Hammer
2 wooden mallets
Marline spikes
Splicing tongs

Procedure

1. Proceed according to the various steps shown in the information.
2. Answer the following questions.

QUESTIONS

1. **What is the difference between a wire-rope short splice and a wire-rope long splice?**
2. **How much ½″ rope should be allowed for a short splice?**
3. **What is the length of the tuck for a ½″ short splice?**

How to Splice 8-Strand Ropes

General Information

Because the hemp center in an eight-strand rope is so much greater in diameter than the strands, it is not practical to tuck the strand ends by the method outlined for splicing six-strand ropes. The strand ends are secured by twisting or tying them together. This is known as the Nash Tuck.

The process for splicing two similar eight-strand ropes, or splicing an eight-strand rope endless, is similar to that for splicing a six-strand rope up to the point where the strands are to be tucked. See Fig. 108. The only difference is that the length of tuck is approximately one-sixteenth the amount of rope allowed for splicing.

The method of tucking the eight pairs of strand ends is the same for each pair.

Procedure

1. Place seizings on the rope on each side of the point where the strands project.
2. Split the strand ends in two back to the seizings. See Fig. 115.

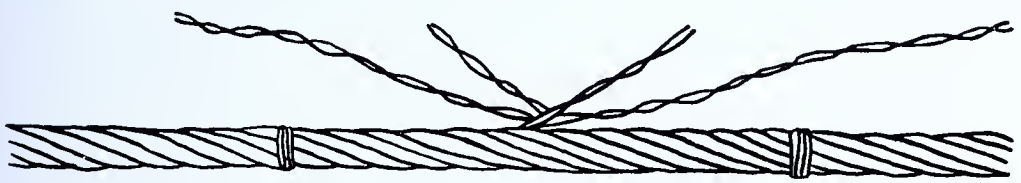


Fig. 115

3. Take one half of each strand end and tie a double knot. See Fig. 116.

   The knot should be drawn down tight by a hand clamp or some similar tool.
4. Insert spike under the three strands beyond the knot, and pull the half strands through. Figure 117 shows one half strand pulled through and the second half strand in the process of being pulled through.

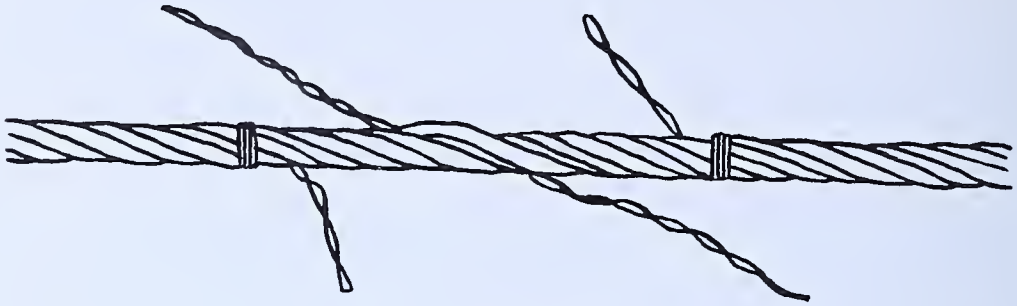


FIG. 116

5. Cut off the two half strands which have been tied and tucked close to the rope, and force each short end into the valley between the strands.

6. Tuck the other two half strands by inserting a marline spike under the adjacent strand and pull the half strand through.

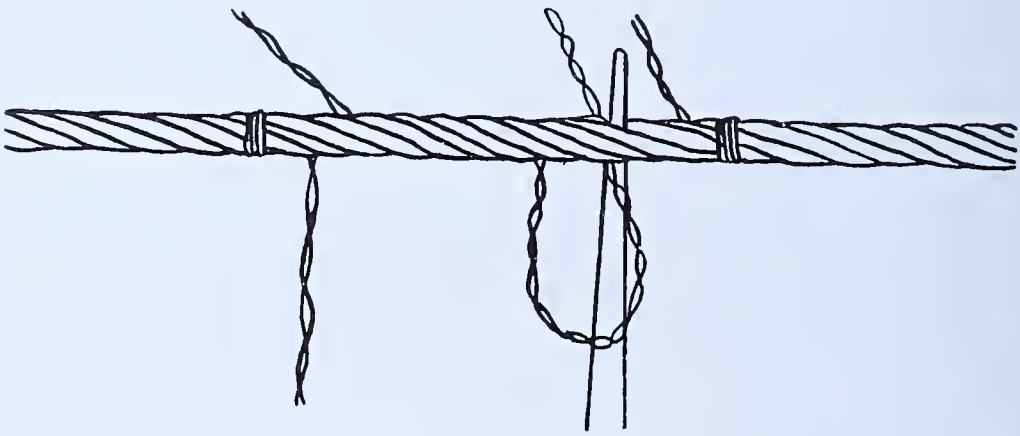


FIG. 117

7. Cut off the ends close to the rope, and force them into the valleys between the strands.

8. With wooden mallets, hammer out any unevenness in the rope as shown in Fig. 113.

FIG. 118 — *One of eight similar points of the finished splice.*

ASSIGNMENT

Splicing an 8-strand Rope

OBJECTIVE

To learn correct methods of splicing wire rope.

TOOLS AND MATERIALS

A hand clamp

Marline spikes

Carew cutter

A piece of 8-strand wire rope.

A wire-rope vise

Jackknife

2 wooden mallets

Splicing tongs

PROCEDURE

1. Follow the procedure outlined in the information sheet.
2. Answer the following questions.

QUESTIONS

1. **What is the Nash Tuck?**
2. **What is the difference between the length of tuck for an 8-strand wire rope and the length of tuck for a 6-strand wire rope?**

How to Splice an Eye in Wire Rope

General Information

While the following directions cover splicing a galvanized thimble into a six-strand wire rope, the process is also used for eight-strand ropes and for splicing eyes into ropes when thimbles are not used.

The process of splicing a thimble into a rope consists of bending the rope about the thimble and fastening the short end by tucking the individual strands under similar strands of the long end of the rope a sufficient number of times to hold them securely. Four tucks are usually sufficient for all ropes containing not more than nineteen wires to the strand. For ropes with more than 19 wires to the strand, five tucks should be used.

A short length of wire rope is consumed in making an eye splice. The amounts required for regular and heavy wire thimbles are shown in Table XV. For larger thimbles, a proportionally greater amount of rope is required.

Table XV

LENGTH OF ROPE TO ALLOW FOR EYE SPLICE

Diameter of Rope in Inches	¼ - ⅜	½	⅝ - ¾	⅞ - 1	1⅛	1¼	1½
Length to Allow in Feet	1	1½	2	2½	3	3½	4

A rigger's vise as shown in the following illustration is adapted for eye splicing. A common bench vise can be used if a rigger's vise is not available.

Procedure

1. Measure off the amount of rope allowed for making the splice.
2. Bend the rope about the thimble at this point, and place rope and thimble in vise. See Fig. 119.

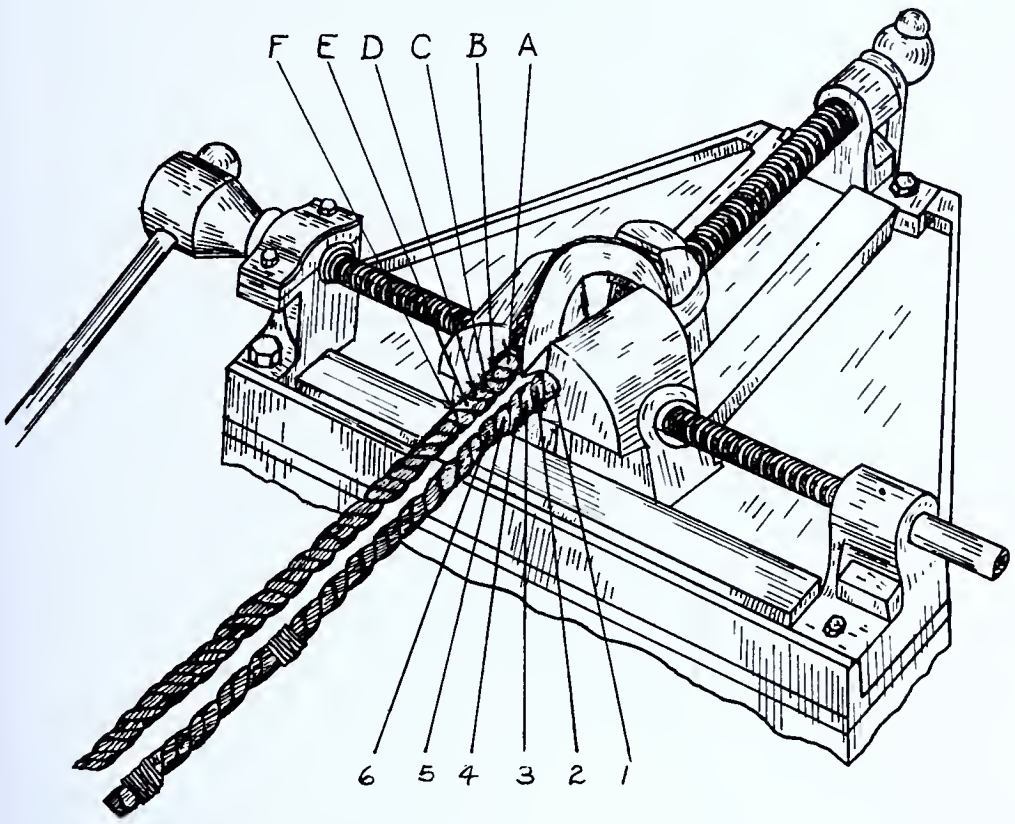


FIG. 119

3. Remove seizings from the short end of the rope and separate the strands.

4. Cut off the hemp center at the point where the strands separate. See Fig. 120.

5. Insert a marline spike under the first two strands nearest the point of thimble, Strands A and B, and rotate the spike a half-turn away from the thimble.

6. Insert Strand 1 through the opening so formed, rotate spike back towards the thimble taking Strand 1 with it, and pull Strand 1 tight. This gives Strand 1 one tuck. See Fig. 121.

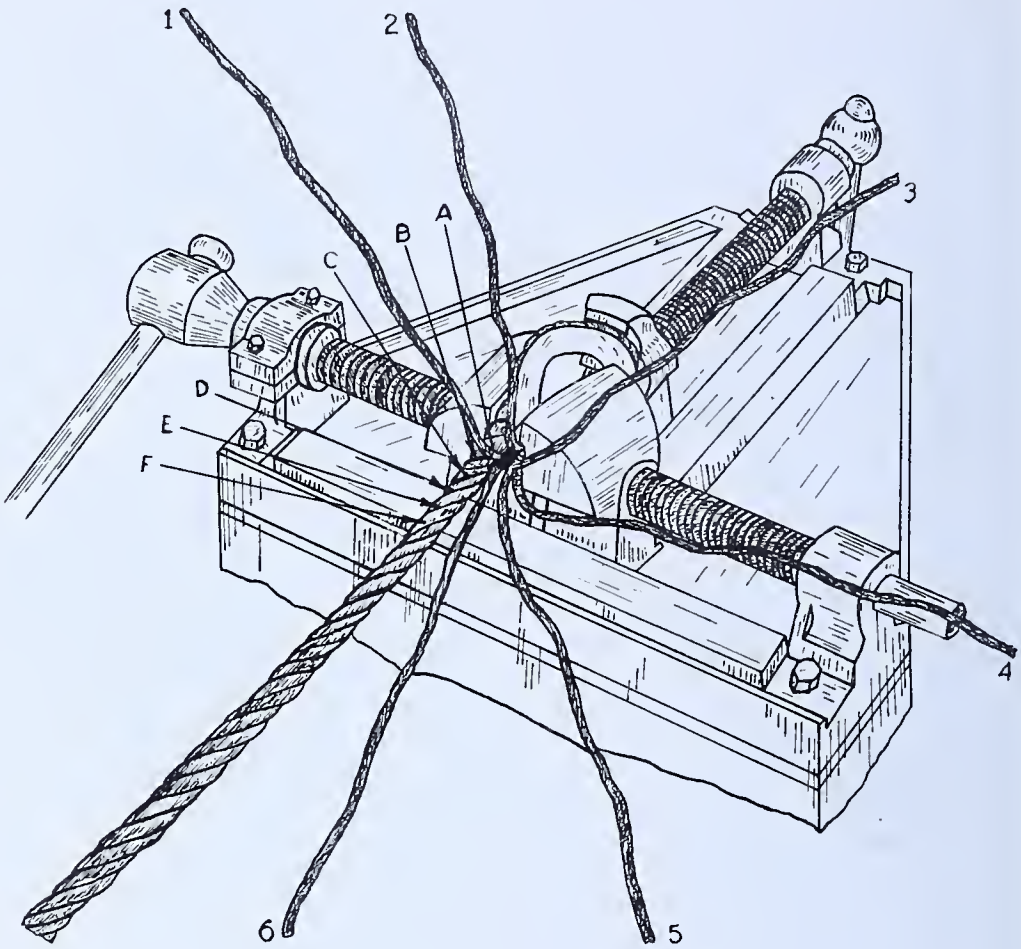


FIG. 120

7. Insert marline spike under next single strand, Strand B, and tuck Strand 2 by the same method.

8. Omit the next strand, Strand C, and insert marline spike under the two strands beyond, Strands D and E, and tuck Strand 6 by inserting it through the opening in the direction opposite to which Strands 1 and 2 were tucked. Rotate the marline spike back to the point of the thimble, force Strand 6 with it, and pull Strand 6 tight. Figure 122 shows the splice at this point. Strands 6, 1, and 2 have been tucked once under Strands F, A, and B, respectively.

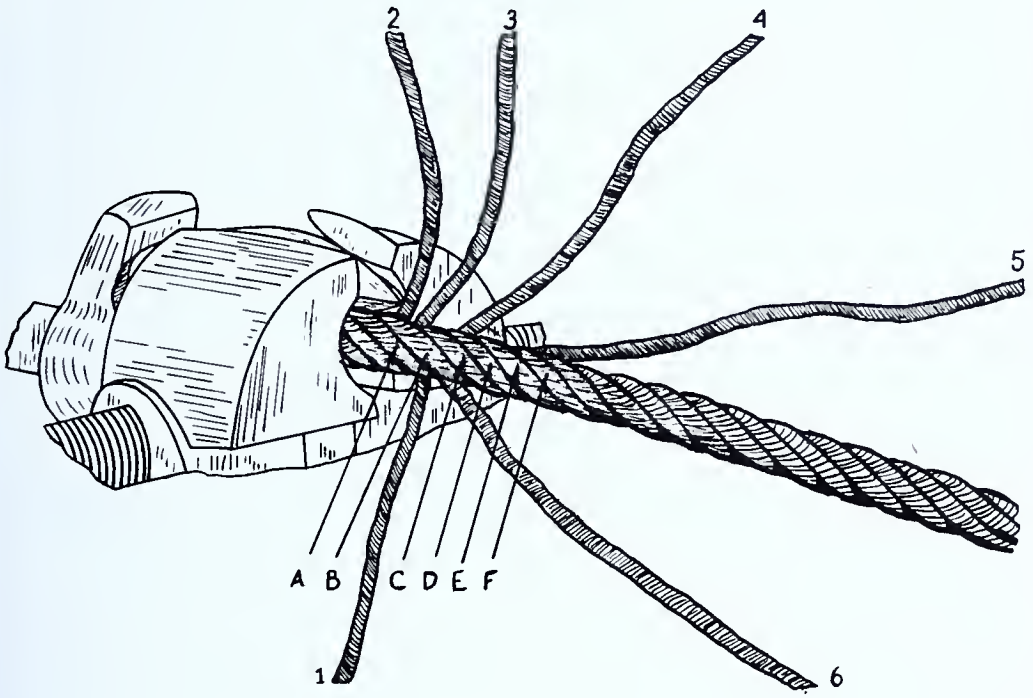


FIG. 121

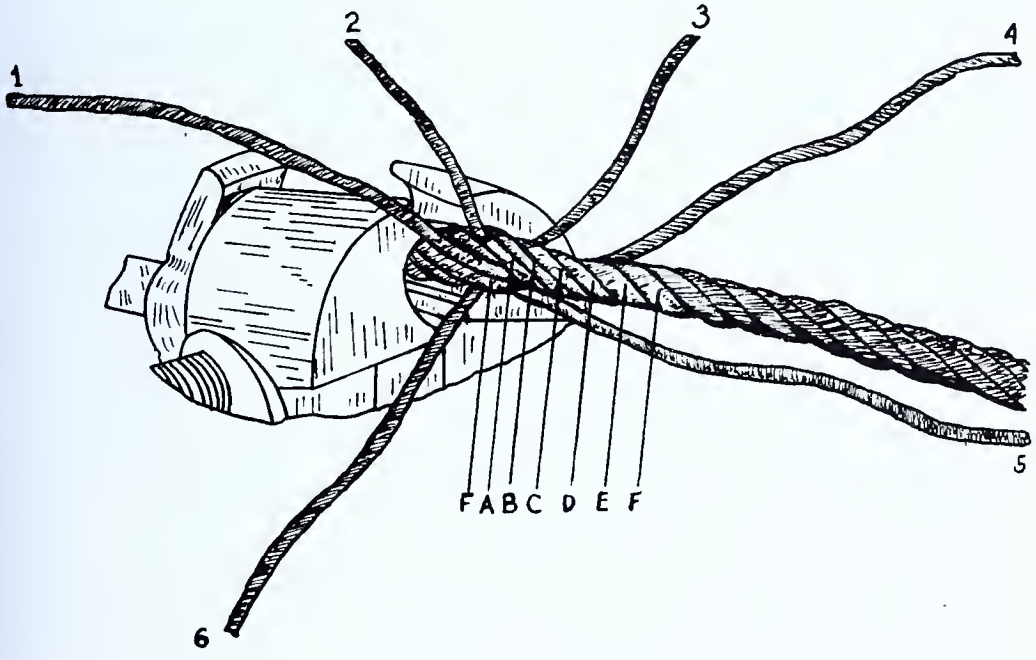


FIG. 122

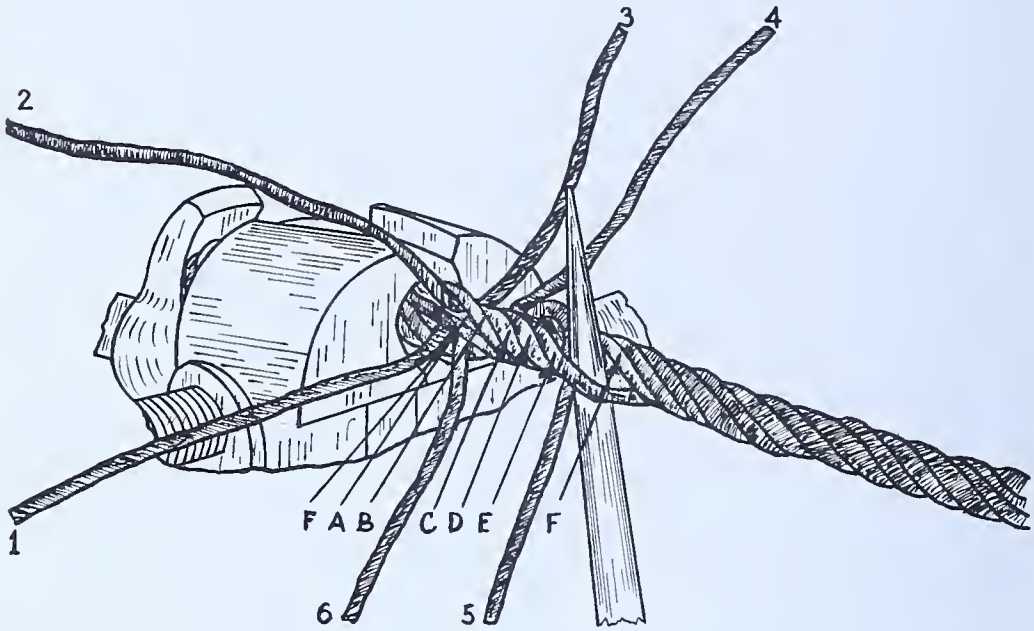


Fig. 123

9. Insert marline spike under Strand E, and tuck Strand 5 in the same manner as Strand 2 was tucked. See Fig. 123.

10. Without removing the marline spike, give Strand 5 three additional tucks. This is accomplished by winding Strand 5 spirally around Strand E three times. Each tuck is made by rotating the spike a half-turn, pulling Strand 5 through the opening, and rotating the spike back toward the thimble to tighten the tuck.

11. Give Strand 4 four tucks by winding it about Strand D in the same manner.

12. Tuck Strand 3 four times about Strand C. Figure 124 shows Strands 3, 4, and 5 after these strands have been given four tucks.

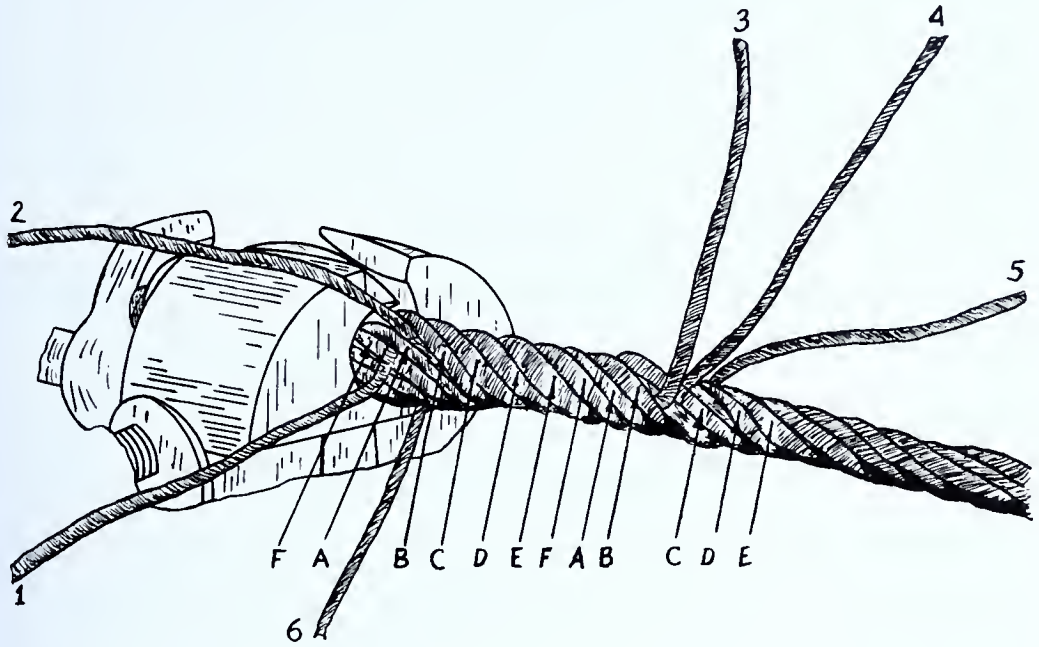


FIG. 124

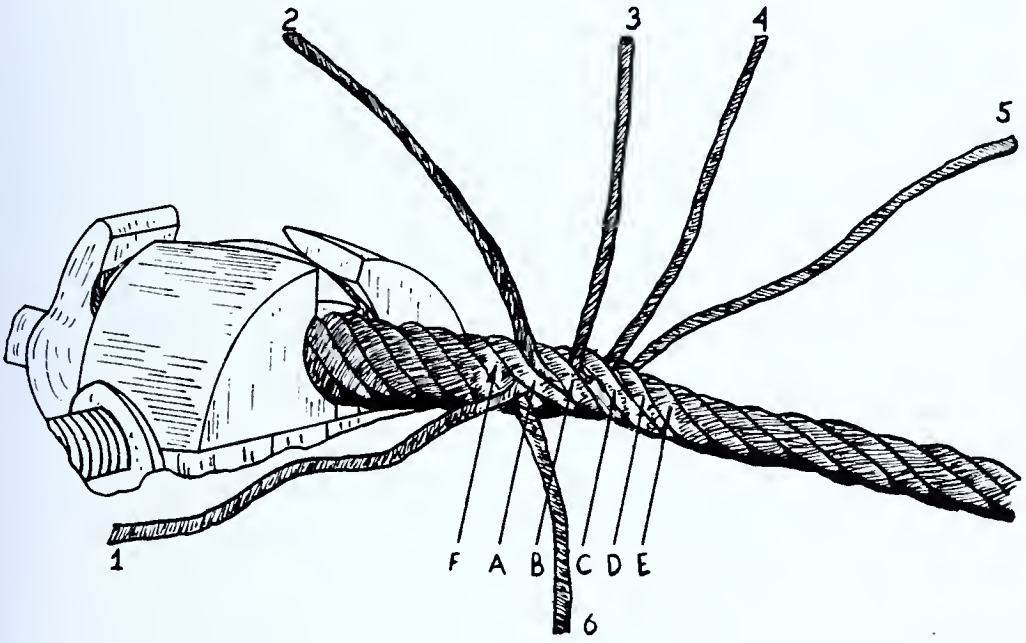


FIG. 125

13. Give Strands 6, 1, and 2, three additional tucks about Strands F, A, and B, respectively, in the manner outlined for Strand 5. Figure 125 shows four completed tucks in each of the six strands. If the rope contains more than nineteen wires per strand, each strand should be given an additional tuck.

    An eye splice made in this manner will have a slight taper as shown in Figs. 126 and 127. If a more pronounced taper is desired, it can be secured by splitting each strand before the final tuck and cutting off a portion of the wires.

14. Cut off the protruding strand close to the rope.

15. Remove any inequalities in the splice by hammering with wooden mallets, as shown in Fig. 113.

16. Wrap the splice with serving wire to protect the hands of workmen handling the rope. This is best accomplished by using a serving iron as shown in Fig. 126.

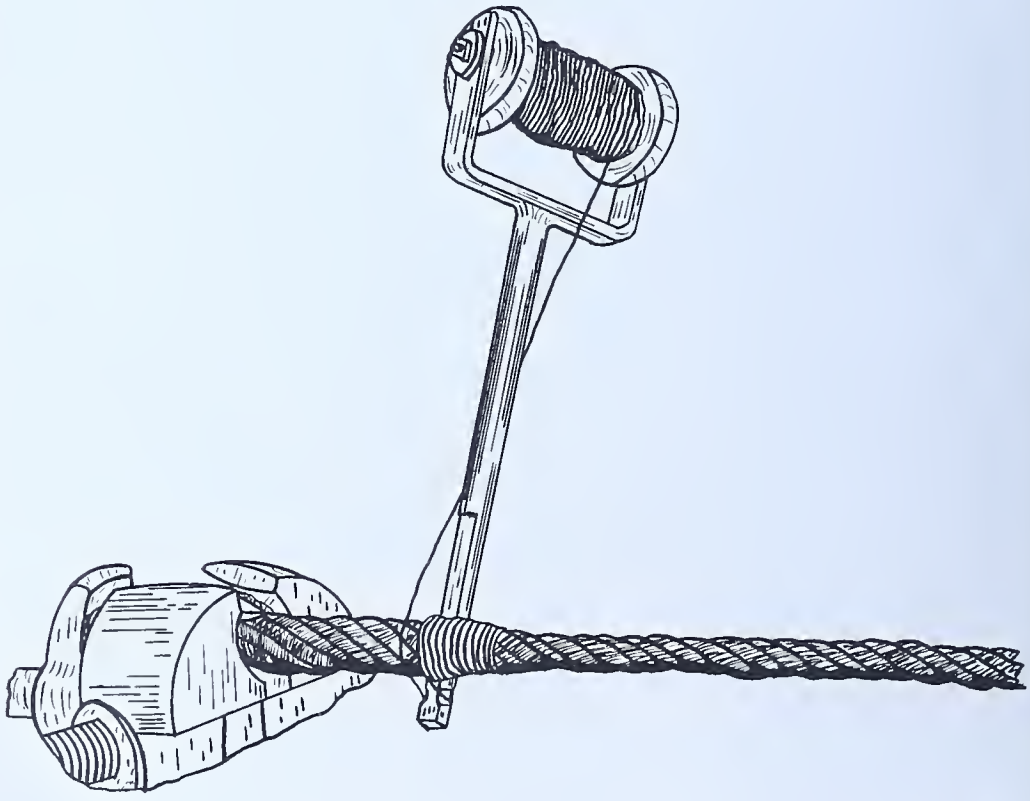


Fig. 126

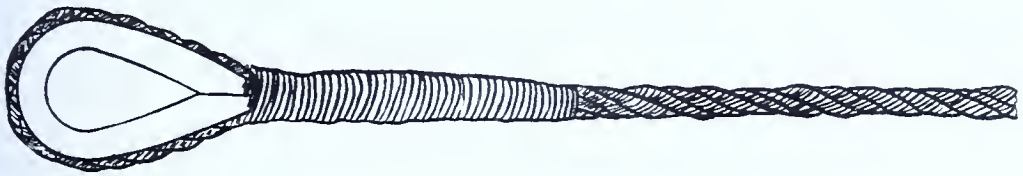


FIG. 127 *shows a Galvanized Heavy Wire Rope Thimble spliced into the end of a 6 x 19 wire rope by the method here outlined.*

FIG. 128 — *The above illustration shows the process of serving a wire rope with marline to protect the hands of the workers. The marline is being wrapped with a serving board. Note the worming and parceling on the wire rope.*

Making a Short Splice

Making a short splice is much the same as making an eye splice. In making a short splice the required length of rope is the same as for an eye splice. The ends of the rope are prepared the same as for an eye splice (Fig. 128A), and they are joined and tucked as shown in Fig. 128B.

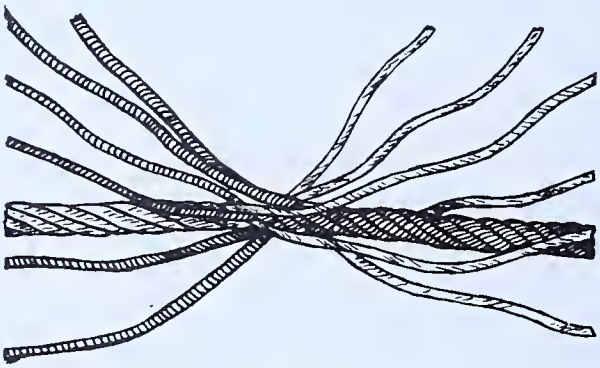


Fig. 128-A

Fig. 128-B

ASSIGNMENT

Splicing an Eye in a Wire Rope

Objective

To learn the method of making splices used on wire rope.

Tools and Materials

1. A rigger's vise
2. Marline spikes
3. Carew cutter
4. Jack knife
5. 2 wooden mallets
6. A serving iron
7. A galvanized thimble
8. A piece of 6-strand wire rope
9. A piece of serving wire

Procedure

1. Follow the procedure given in the information sheet.
2. Answer the following questions.

QUESTIONS

1. **How many feet of wire rope should be allowed for splicing an eye into a ½″ wire rope?**
2. **What is a marline spike?**
3. **Why is the splice wrapped with a serving wire?**

An Alternate Method of Splicing Wire Rope

General Information

Wire-rope splicing at the Sun Shipyard is done with the wire rope in a vertical position, which differs somewhat from the method previously shown. The advantage of the vertical position is that the workmen can work all around the wire and not have to turn the splice over or get down underneath for some of the tucks.

Fig. 129 — *Splicing Wire Rope in a Vertical Position*

Procedure

1. Bend and seize wire rope around thimble or to size of eye if there is no thimble.
2. Place the wire rope in the vise in a vertical position and haul it up tight with a block as shown in the illustration.
3. Fasten an iron rod to the wire rope with a chain stopper as shown, sufficiently above the worker's head to be out of the way.

4. Make fast the heaving end of the fall so that the rope is well out of the way.
5. Turn the iron rod enough to loosen up the strands of the rope and then lash the bar to the heaving rope. Loosening the lay facilitates tucking the strands by making it easier to insert the marline spike between the various strands.
6. Rotate the marline spike with the lay of the rope.
7. Tuck the first strand under two strands to the left.
8. Insert the first strand beneath the spike and pull it through as far as possible.

FIG. 129A — *Showing the Method of Breaking Off the Remaining Half Strands.*

9. Pull on the strand and reverse the rotating of the spike, forcing the strand down into place.
10. Insert the second strand under third strand to right of rope heart.
11. Tuck the remaining strands under one strand.
12. Repeat this operation until all the strands are tucked at least five and one-half times.
13. On the last tucks, split the strands and tuck only half of them.
14. Break off the remaining half strands, or, if the rope is large, burn them off with a torch. Great care must be exercised when using a torch so that the flame does not touch the wires except the ends being cut off.

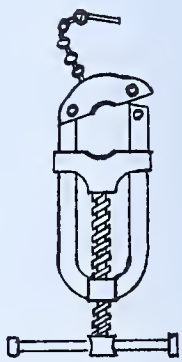


FIG. 130 — *Portable Rigging Screw. Used for Splicing Small Wire and Ropes Out on the Job.*

[15]
ATTACHING WIRE ROPE FITTINGS*

How to Attach a Socket

General Information

Babbit metal or lead should not be used for socketing wire ropes because the strength of the fastening made with these metals will be much less than the strength of the rope. A drop to 25% of the strength of the rope is not uncommon for the holding power of a socketed terminal connection attached with alloys of low melting point.

It is recommended that zinc of the highest commercial purity be used.

The molten zinc when poured into the socket basket should not be too hot or it will anneal the wires, particularly those in small wire ropes. The temperature should not be more than 830° F. If the zinc is at the proper temperature, a soft pine stick dipped into it should be only slightly discolored by scorching. If the zinc adheres to the stick, it is too cold for pouring. If the stick is charred, the zinc is too hot.

The practice here detailed is recommended by the United States Bureau of Mines in Bulletin No. 75. It is a most satisfactory method.

Procedure

1. Place an additional seizing on the rope end to be socketed at a distance equal to the length of the basket of the socket from the end of the rope. It is important that this seizing be carefully applied and of sufficient length to prevent any untwisting of the strands, which would result in unequal tension on the strands when socket is attached.

2. Place rope end upright in bench vise as shown in Fig. 131.

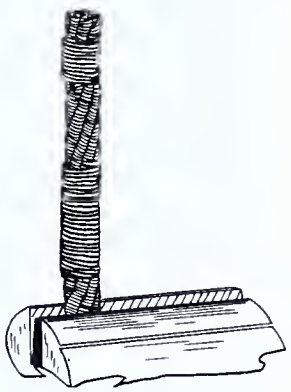


Fig. 131

*This information was adapted from material furnished by the American Steel and Wire Company.

3. Remove any seizing above the one referred to in previous paragraph.
4. Cut the hemp center at the seizing. See Fig. 132.
5. Untwist the strands and broom out the wires. The wires should be separated, but not straightened. See Fig. 133.
6. Clean the wires for the distance they are to be inserted in the socket with benzine, naphtha, or gasoline, and then dip in a bath of muriatic acid solution (50% commercial muriatic acid and 50% water) from 30 to 60 seconds, or until the acid has thoroughly cleaned each wire. Care should be taken to prevent acid's coming in contact with the hemp core or any portion of the rope other than the broomed wire end. Next, the acid should be neutralized by dipping the wires into boiling water, to which has been added a small amount of soda.
7. Draw the ends of the wires together by serving broomed end with a piece of Manila rope so that the socket can be forced down over them. See Fig. 133A.
8. Force the socket down over the rope end until it reaches the seizing on the wire rope. See Figs. 134 and 135.
9. Remove the seizing wire from the wires and allow the wires to expand within the socket basket. The ends of the wires should be level with the upper end of the socket basket.

   Care should be taken to see that the axis of the socket is in line with the axis of the rope.
10. Seal the base of the socket with putty, clay, or similar substance.
11. Preheat the basket of the socket to expel any moisture and to keep the molten zinc from congealing before it has completely filled the lower end of the basket.

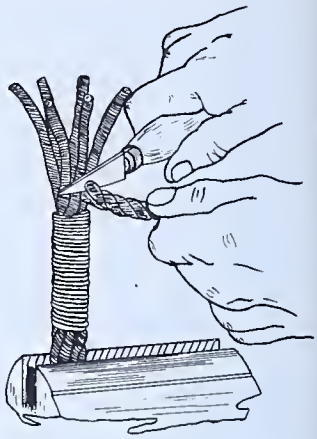


Fig. 132

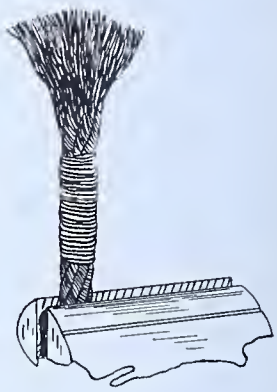


Fig. 133

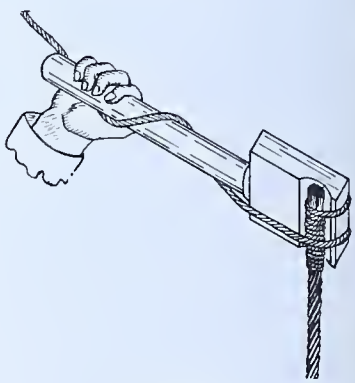


Fig. 133A

12. Fill the socket basket with molten zinc. The zinc must not be too hot or it will anneal the wires, particularly on small ropes or ropes of small wires. From 800 to 875° F. is the correct temperature. See Fig. 135.
13. When the zinc has congealed, plunge the socket into cold water to cool it.
14. Remove the seizing.

Figure 136 shows a wire rope socket before the seizing was removed.

If the socketing is properly done, a wire rope, when tested to destruction, will break before it will pull out of the socket.

FIG. 134

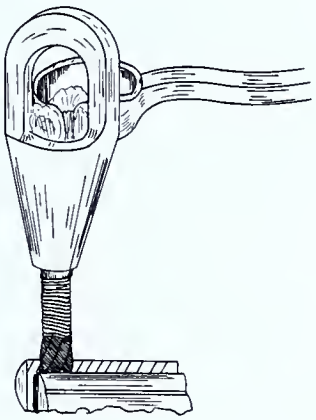


FIG. 135

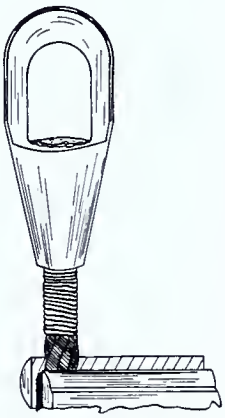


FIG. 136

ASSIGNMENT

Attaching Sockets

OBJECTIVE

To learn how to attach fixtures to wire rope.

TOOLS AND MATERIALS

Carew cutter
Jackknife
Water-heating device
Zinc-melting device
A ladle
A container for cold water
A welding torch
A socket
Cold water
A wire rope
Seizing wire
Zinc
Benzine, naphtha, or gasoline
Commercial muriatic acid
Boiling water
Soda
Putty or clay
Serving mallet
Six-thread Manila rope, short length

PROCEDURE

1. Follow the procedure given in the information.
2. Answer the following questions.

QUESTIONS

1. **How can one tell when the molten zinc is ready to pour?**
2. **Why should the socket be in line with the axis of the wire rope?**
3. **Why not use babbit or lead for socketing?**
4. **How are the wire rope ends prepared for "socketing"?**
5. **Why must particular care be used in cleaning the wire rope ends?**

Open Wire Rope Sockets

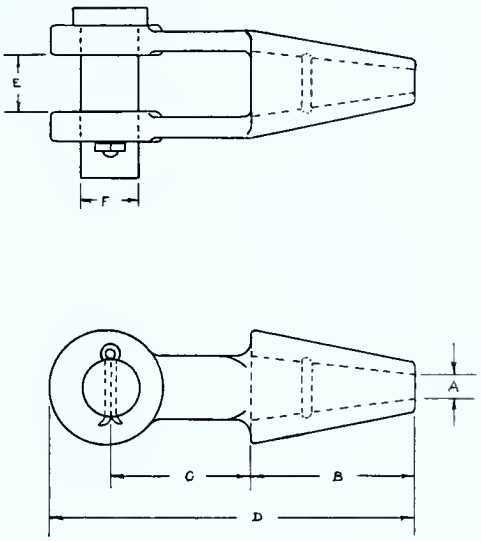


FIG. 137

Table XVI
DIMENSIONS OF SOCKETS

Rope Diam. A	Length of Basket B	Distance from Basket to Center Line of Pin C	Over-all Length D	Opening Between Jaws E	Diam. of Pin F	Approx. Weight Pounds
1/4-5/16	2	1 9/16	4 5/16	11/16	11/16	0.9
3/8	2	1 3/4	4 5/8	13/16	13/16	1.1
1/2-9/16	2 1/2	2	5 9/16	1	1	2.3
5/8	3	2 1/2	6 3/4	1 1/4	1 3/16	3.8
3/4	3 1/2	3	7 15/16	1 1/2	1 3/8	6.0
7/8	4	3 1/2	9 1/4	1 3/4	1 5/8	10.0
1	4 1/2	4	10 9/16	2	2	15.5
1 1/8	5	4 1/2	11 13/16	2 1/4	2 1/4	22.0
1 1/4	5 1/2	5	13 3/16	2 1/2	2 1/2	32.0
1 3/8	5 1/2	5	13 3/16	2 1/2	2 1/2	32.0
1 1/2	6	6	15 1/8	3	2 3/4	46.0
1 5/8	6 1/2	6 1/2	16 1/4	3	3	55.0
1 3/4	7 1/2	7	18 1/4	3 1/2	3 1/2	82.0
1 7/8	7 1/2	7	18 1/4	3 1/2	3 1/2	82.0
2-2 1/8	8 1/2	9	21 1/2	4	3 3/4	120.0
2 1/4-2 3/8	9	10	23 1/2	4 1/2	4 1/4	160.0

Pins are turned. Holes are 1/32-inch larger than pin diameters.

Closed Wire Rope Sockets

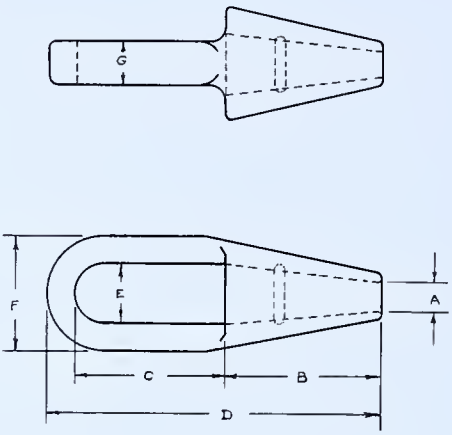


Fig. 138

Table XVII
DIMENSIONS OF SOCKETS

Rope Diam. A	Length of Basket B	Length of Opening C	Over-all Length D	Width of Opening E	Width of Loop F	Depth of Loop G	Approx. Weight Pounds
1/4-5/16	2	1 13/16	4 1/4	11/16	1 7/16	1/2	0.5
3/8	2	2 1/16	4 5/8	15/16	1 11/16	5/8	0.8
1/2-9/16	2 1/2	2 5/16	5 1/2	1 1/8	2	7/8	1.6
5/8	3	2 9/16	6 3/8	1 3/8	2 5/8	1	3.0
3/4	3 1/2	3 1/16	7 5/8	1 5/8	3	1 1/4	4.5
7/8	4	3 5/8	8 7/8	1 7/8	3 5/8	1 1/2	7.0
1	4 1/2	4 1/8	10	2 1/4	4 1/8	1 3/4	11.0
1 1/8	5	4 5/8	11 1/8	2 1/2	4 1/2	2	16.0
1 1/4	5 1/2	5 3/16	12 5/16	2 3/4	5	2 1/4	22.0
1 3/8	5 1/2	5 3/16	12 5/16	2 3/4	5	2 1/4	22.0
1 1/2	6	6 3/16	14 1/8	3 1/8	5 3/8	2 1/2	28.0
1 5/8	6 1/2	6 3/4	15 3/8	3 1/4	5 3/4	2 3/4	36.0
1 3/4	7 1/2	7 13/16	17 1/2	3 17/32	6 3/4	3	53.0
1 7/8	7 1/2	7 13/16	17 1/2	3 17/32	6 3/4	3	53.0
2-2 1/8	8 1/2	8 13/16	19 3/4	3 25/32	7 5/8	3 1/4	80.0
2 1/4-2 3/8	9	9 3/4	21 5/8	4 9/32	8 1/2	3 5/8	105.0

Clips or Clamps

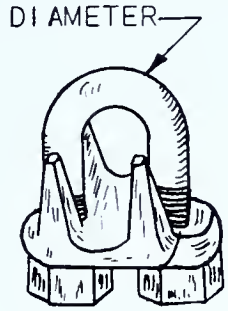


FIG. 139 — *Clip or Clamp*

Table XVIII
DIMENSIONS OF CLIPS OR CLAMPS

Rope Diam.	Diam. of U-Bolt	Approx. Wt. in Lbs.	No. Clips for Each Rope End
3/16	5/16	.14	2
1/4	3/8	.29	2
5/16	3/8	.30	2
3/8	7/16	.46	2
7/16	1/2	.73	2
1/2	1/2	.73	3
5/8	9/16	1.00	3
3/4	5/8	1.46	3
7/8	3/4	2.41	4
1	3/4	2.66	4
1 1/8	3/4	3.35	5
1 1/4	7/8	4.63	5
1 3/8	7/8	5.00	6
1 1/2	7/8	5.48	6
1 5/8	1	6.91	6
1 3/4	1	7.67	6
2	1	10.4	6
2 1/4	1 1/8	13.6	6
2 1/2	1 1/8	15.9	6

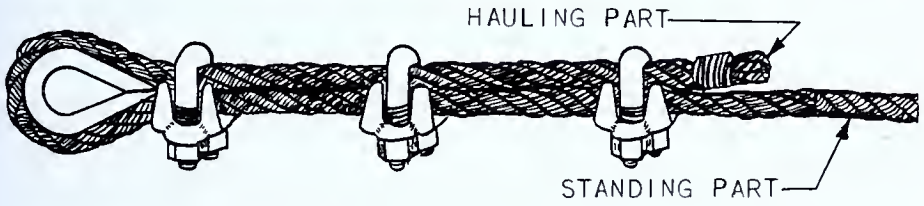


FIG. 140 — *Proper Application of Wire Rope Clamps*

How to Attach Clips or Clamps

General Information

Wire Rope Clips are easy to apply; they are reliable and durable. When protected from corrosion by a heavy coating of pure zinc applied by the hot galvanizing process, clips may be used repeatedly.

In addition to the drop forged steel clips, wire rope clips are forged from high strength bronze. These bronze clips are designed for use where electrolysis or corrosion makes the use of steel clips impracticable. Dropped from the same forging dies as are the steel clips, these high strength bronze clips are full size. They weigh approximately 10% more than the steel clips and are approximately 25% less strong. When high strength bronze clips are used on wire ropes, one clip more than recommended above should be used for each fastening. See Table XVIII.

It is possible to hold wire ropes with fewer clips than specified above, but the increased pressure required reduces the efficiency of the connection.

The clips should be attached to the rope ends as shown in Figure 140: the base of the clip against the live or long end, and the U bolt bearing against the dead, or short end of the rope. This is the only correct method of attaching wire rope clips.

The clips should be spaced at least six rope diameters apart to insure maximum holding power. After the rope has been placed in service and is under tension, the nuts should be tightened again to compensate for any decrease in rope diameter caused by the load.

ASSIGNMENT

Attaching Clips

Objective

To learn how to attach fixtures to wire rope.

Tools and Materials

Socket wrench
Carew cutter
Wire-rope vise
Wire rope
Thimble
As many clips as required in Table XVIII
Seizing wire

PROCEDURE

1. Place a seizing near the end of the wire rope.
2. Bend the wire rope around the thimble. It may be necessary to hold the rope in a vise if the wire rope is large.
3. Place the clip nearest to the thimble with the base against the live or long end, and tighten it securely with a socket wrench.
4. The other clips should be placed in the same position and spaced at proper intervals according to the size of the wire rope.
5. Make sure that there are enough clips for the size of rope used.
6. Answer the following questions.

QUESTIONS

1. **For what are clips used?**
2. **How far apart should clips be placed?**
3. **When should bronze clips be used?**
4. **Which are stronger, drop forged or bronze clips?**
5. **Is the U bolt of a wire rope clip applied to the hauling part or the standing part of the wire rope?**

Galvanized, Standard Wire Rope Thimbles

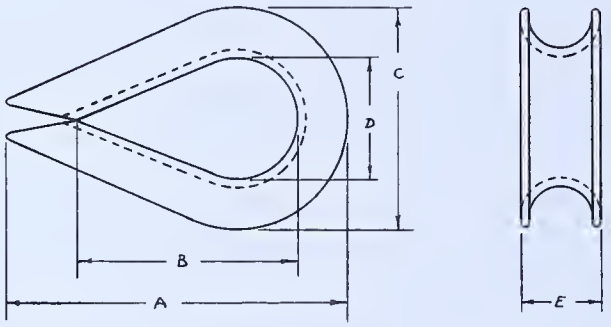


FIG. 141

Table XIX

DIMENSIONS OF THIMBLES IN INCHES

Rope Diam.	Length A	Length of Opening B	Width C	Width of Opening D	Depth E	Diam. of Largest Pin Thimble Will Take	Approx. Weight Pounds
1/8	1 5/8	1 1/8	31/32	5/8	1/4	9/16	.025
3/16	1 3/4	1 3/16	1 3/16	11/16	5/16	5/8	.03
1/4	2	1 5/16	1 5/16	3/4	3/8	11/16	.05
5/16	2 1/4	1 1/2	1 7/16	7/8	7/16	13/16	.07
3/8	2 3/8	1 9/16	1 5/8	1	1/2	15/16	.08
7/16	2 3/4	1 5/8	1 3/4	1 1/16	9/16	1	.14
1/2	3	1 7/8	1 15/16	1 1/8	5/8	1 1/16	.17
5/8	3 3/4	2 1/4	2 5/16	1 3/8	7/8	1 1/4	.38
3/4	4	2 1/2	2 5/8	1 5/8	1	1 1/2	.50
7/8	4 1/2	2 3/4	2 7/8	1 3/4	1 1/8	1 5/8	.62
1	6	4 1/4	3 1/2	2	1 1/4	1 7/8	1.05
1 1/8	7 1/8	4 1/2	4 1/4	2 1/2	1 3/8	2 3/8	2.81
1 1/4	7 1/8	4 3/4	4 5/8	2 3/4	1 5/8	2 5/8	3.00
1 1/2	7 3/4	4 7/8	5 1/8	3	1 7/8	2 7/8	3.15
1 3/4	9 1/4	5	6	3 1/2	2 1/8	3 3/8	5.50
2	11	7	7 1/4	4 1/2	2 3/8	4 3/8	7.50

Galvanized, Standard Wire Rope Thimbles are recommended for use with Iron and Cast-Steel Ropes, Galvanized Guy Strands and Ropes, and Stationary Ropes

Galvanized, Heavy Wire Rope Thimbles

Galvanized, Heavy Wire Rope Thimbles are recommended for use with all material-handling ropes, and all Plow-Steel and Monitor Steel-Wire Ropes.

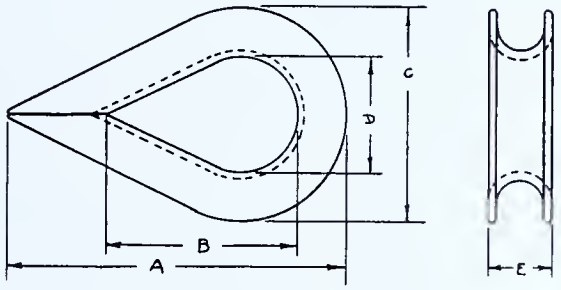


FIG. 142

Table XX

DIMENSIONS OF THIMBLES IN INCHES

Rope Diam.	Length A	Length of Opening B	Width C	Width of Opening D	Depth E	Diam. of Largest Pin Thimble Will Take	Approx. Weight Pounds
1/4	2-1/2	1-5/8	1-9/16	7/8	13/32	13/16	.12
5/16	3	1-7/8	1-13/16	1	15/32	15/16	.15
3/8	3-3/8	2-1/8	2-1/16	1-1/8	1/2	1- 1/16	.22
7/16	3-3/4	2-1/2	2-1/4	1-1/4	5/8	1- 3/16	.30
1/2	4-1/8	2-3/4	2-5/8	1-1/2	23/32	1- 7/16	.50
9/16	4-1/8	2-3/4	2-5/8	1-1/2	25/32	1- 7/16	.50
5/8	5-1/2	3-1/4	3-3/16	1-3/4	29/32	1- 5/8	.75
3/4	6-1/2	3-3/4	3-3/4	2	1- 1/16	1- 7/8	1.30
7/8	7-1/8	4-1/4	4-1/16	2-1/4	1- 3/16	2- 1/8	1.60
1	8-1/8	4-1/2	4-11/16	2-1/2	1- 7/16	2- 3/8	2.80
1-1/8	9-1/2	5	5-5/8	2-7/8	1- 5/8	2- 3/4	4.50
1-1/4	9-1/2	5-1/8	5-5/8	2-7/8	1-11/16	2- 3/4	4.50
1-3/8	11-5/8	6-1/4	6-7/8	3-1/2	2- 1/16	3- 3/8	7.50
1-1/2	11-5/8	6-1/4	6-7/8	3-1/2	2- 1/8	3- 3/8	7.50
1-5/8	13-3/8	8	7-3/4	4	2- 3/8	3- 7/8	11.75
1-3/4	14	9	8-1/2	4-1/2	2- 3/4	4- 3/8	18.00
1-7/8	15	10	9-1/4	5	2- 7/8	4- 7/8	22.00
2	17	12	10-1/2	6	3- 1/8	5- 7/8	30.00
2-1/8	19	14	12-1/4	7	3- 1/2	6- 7/8	52.00
2-1/4	19	14	12-1/4	7	3- 1/2	6- 7/8	52.00

Galvanized, Standard Hawser Thimbles

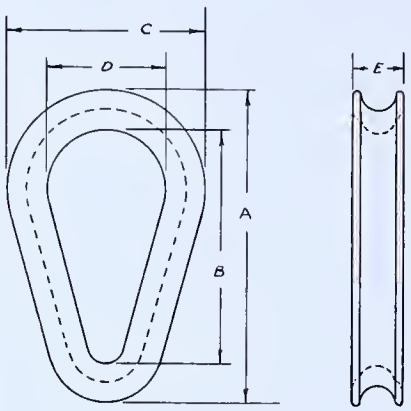


Fig. 143

Table XXI

GALVANIZED STEEL CASTINGS

Size of Hawser in Inches		Dimensions of Thimbles in Inches					Approx. Weight Pounds
		Length	Length of Opening	Width	Width of Opening	Depth	
Diameter	Circumference	A	B	C	D	E	
5/8	2	6 1/2	4 1/2	5	3	1 3/16	4
3/4	2 3/8	6 1/2	4 1/2	5	3	1 3/16	4
7/8	2 3/4	8 1/4	5 3/4	6 1/4	3 3/4	1 7/16	7
1	3 1/8	8 1/4	5 3/4	6 1/4	3 3/4	1 7/16	7
1 1/8	3 1/2	9 3/4	6 3/4	7 1/4	4 1/4	1 11/16	9
1 1/4	3 7/8	9 3/4	6 3/4	7 1/4	4 1/4	1 11/16	9
1 3/8	4 3/8	10 1/2	7 1/8	7 3/4	4 1/2	1 15/16	13
1 1/2	4 3/4	12	8	9	5	2 3/16	20
1 5/8	5 1/8	12 1/4	8	9 1/4	5	2 7/16	26
1 3/4	5 1/2	12 1/4	8	9 1/4	5	2 7/16	26
1 7/8	5 7/8	14 1/4	9 1/2	10 3/4	6	2 11/16	36
2	6 1/4	14 1/4	9 1/2	10 3/4	6	2 11/16	36
2 1/8	6 5/8	16 1/2	11	12 1/2	7	3 1/8	53
2 1/4	7 1/8	16 1/2	11	12 1/2	7	3 1/8	53

This type of thimble is recommended for heavy towing ropes and other severe-service conditions where safety and rope protection are of prime importance.

Hooks for Wire Rope

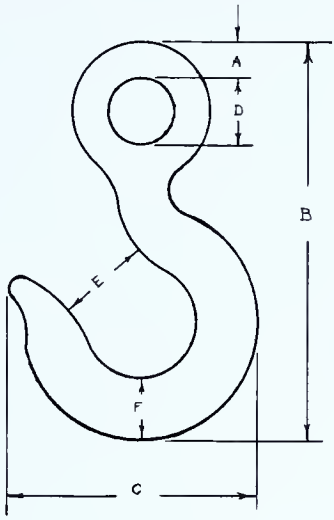


FIG. 144

Table XXII

DIMENSIONS OF WIRE ROPE HOOKS IN INCHES

Safe Working Load in Pounds	Size at A	Length B	Width C	Inside Diam. of Eye D	Opening E	Depth F	Approx. Weight Pounds	Diameter of Best Grade Plow Steel Wire Rope to be Used in Inches
1,000	9/32	4 1/2	2 7/8	3/4	7/8	7/8	.75	1/4
1,500	11/32	5 1/4	3 3/8	7/8	1	1	1.00	1/4
2,000	23/64	5 3/4	3 7/8	1	1 1/8	1 1/16	1.75	5/16
3,000	15/32	6 3/4	4 5/16	1 1/4	1 1/4	1 3/8	2.75	3/8
4,000	63/64	7 1/2	4 3/4	1 3/8	1 3/8	1 7/16	3.38	7/16
5,000	18/32	8 1/2	5 1/2	1 1/2	1 1/2	1 5/8	4.50	1/2
6,000	5/8	9 1/4	6	1 5/8	1 5/8	1 7/8	6.38	9/16
7,500	11/16	10 1/4	6 3/4	1 3/4	1 7/8	2	8.50	5/8
9,000	23/32	11 1/4	7 5/8	2	2	2 1/8	11.00	11/16
2,000	55/64	13	8 1/4	2 1/4	2 1/8	2 1/2	16.25	3/4
5,000	15/16	14	8 7/8	2 1/2	2 1/4	2 3/4	21.3	7/8
0,000	1 1/8	15 1/2	10 1/16	2 3/4	2 1/2	3 1/8	27.0	1
4,000	1 5/32	16 1/2	11	3	2 3/4	3 3/8	33.5	1-1/8
8,000	1 9/32	18	12 1/8	3 1/4	3 1/4	3 3/4	42.0	1-1/4
4,000	1 3/8	19 3/4	13 3/8	3 1/2	3 5/8	4	50.0	1-3/8
0,000	1 1/2	21 1/2	14 1/2	3 3/4	4	4 3/8	65.0	1-1/2
4,000	1 11/16	23	15 7/8	4	4 1/2	4 3/4	82.0	1-5/8
0,000	1 23/32	24 1/2	16 1/2	4 1/4	4 3/4	4 7/8	105.0	1-3/4
0,000	1 15/16	26	18 1/2	4 1/2	5	5 5/8	130.0	1-7/8

Hooks for Manila rope have considerably larger eyes.

Wire Rope Links and Rings

The long link is the standard link used for wire rope fittings.

The short link is used to connect other fittings, such as the long link to one end and hook to other end of double pattern switch ropes.

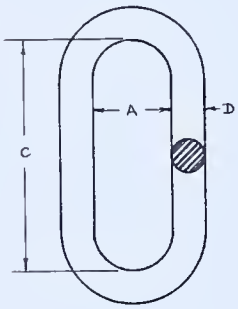


Fig. 145

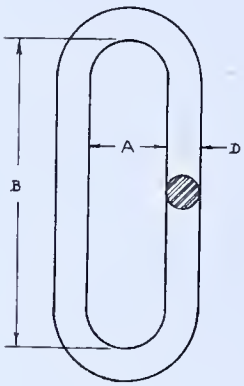


Fig. 146

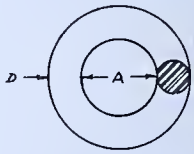


Fig. 147

Table XXIII
LINKS AND RINGS

Safe Working Load in Pounds	Long and Short Links and Rings		Long Links		Short Links		Rings	Diameter of Best Grade Plow Steel Wire Rope to be Used in Inches
	Inside Width A	Diam. of Stock D	Inside Length B	Approx. Weight Pounds	Inside Length C	Approx. Weight Pounds	Approx. Weight Pounds	
2,000	1	3/8	4	.3	3	.25	.125	5/16
3,000	1 1/4	1/2	6	1.0	4	.7	.294	3/8
5,000	1 1/2	5/8	8	2.0	4	1.0	.566	1/2
7,500	1 3/4	3/4	9	3.0	5	2.0	1.187	5/8
9,000	2	7/8	9	4.0	5	2.4	1.378	11/16
12,000	2 1/4	1	10	6.0	6	4.0	2.044	3/4
15,000	2 1/2	1 1/8	10	8.0	6	5.5	3.53	7/8
20,000	2 7/8	1 1/4	10	10.0	6	7.0	4.81	1
24,000	3 1/8	1 3/8	11	12.5	8	10.0	5.02	1-1/8
28,000	3 5/8	1 1/2	11	16.0	8	13.0	8.62	1-1/4
34,000	3 7/8	1 5/8	12	20.0	8	15.0	10.15	1-3/8
40,000	4	1 3/4	12	24.0	9	20.0	13.185	1-1/2
44,000	4 1/4	1 7/8	12	28.0	9	22.0	14.58	1-5/8
50,000	4 1/2	2	12	32.0	9	26.5	18.49	1-3/4
60,000	5	2 1/4	14	45.0	10	36.0	24.73	1-7/8
85,000	5 1/2	2 1/2	14	59.0	10	48.0	35.48	2-1/4

Anchor Shackles

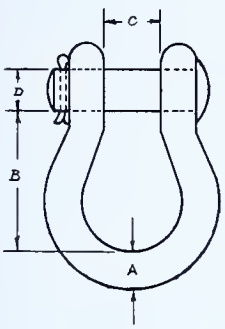


FIG. 148

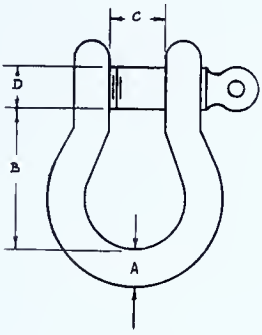


FIG. 149

Table XXIV

DIMENSIONS OF ANCHOR SHACKLES IN INCHES

Size A	Length of Opening B	Distance Between Eyes C	Diameter of Pin D	Safe Load 2000 tons Screw Pin	Approx. Weight Pounds
1/4	1 1/8	1/2	5/16	.44	.12
5/16	1 1/4	9/16	3/8	.68	.20
3/8	1 1/2	11/16	7/16	.88	.30
7/16	1 3/4	11/16	1/2	1.32	.49
1/2	2	7/8	5/8	1.72	.75
5/8	2 3/8	1 1/16	3/4	2.9	1.45
3/4	2 7/8	1 1/4	7/8	3.9	2.2
7/8	3 1/4	1 3/8	1	5.3	3.4
1	3 5/8	1 11/16	1 1/8	6.5	5.0
1 1/8	4 1/4	1 7/8	1 1/4	7.6	7.4
1 1/4	4 3/4	1 7/8	1 3/8	9.5	10.0
1 3/8	5 1/4	2 1/4	1 1/2	11.6	12.8
1 1/2	5 1/2	2 1/4	1 5/8	13.8	16.0
1 3/4	7	2 7/8	2	21.2	29.4
2	7 3/4	3 1/8	2 1/4	25.6	41.6

Notice that the diameter of pin exceeds the diameter of stock of shackle.

Eye End Turnbuckles

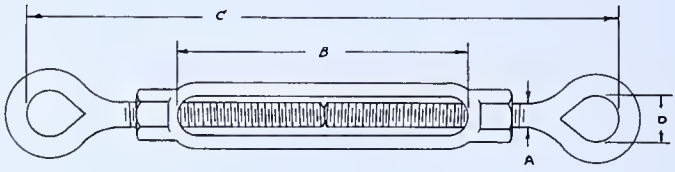


FIG. 150

Table XXV

DIMENSIONS OF EYE END TURNBUCKLES

Size A	Takeup B	Minimum Length Pull to Pull of eyes C	Width of Opening D	Approx. Weight Pounds	Safe Load in tons of 2000 lbs.
1/4	4	7 3/8	15/32	.3	1/4
5/16	4 1/2	8 1/2	17/32	.5	1/2
3/8	6	10 3/4	19/32	.8	2/3
1/2	6	12	3/4	1.6	1 1/4
5/8	6	13 1/4	15/16	2.7	2
3/4	9	18	1 1/4	4.8	3
7/8	12	22 1/4	1 1/4	8.	4
1	12	24	1 7/16	11.	5 1/2
1 1/8	12	24 1/4	1 9/16	13.	6 1/2
1 1/4	12	26 3/4	1 11/16	18	8 1/2
1 1/2	18	34 7/8	2 3/16	32	13
1 3/4	18	38	2 1/2	49	17 1/2
2	24	47	3	78	23
2 1/4	24	53	3 3/4	135	30
2 1/2	24	58	3 3/4	145	37

Shackle End Turnbuckles

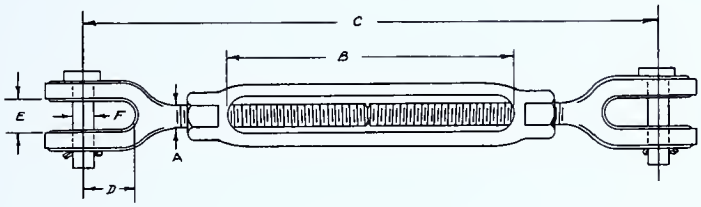


FIG. 151

Table XXVI

DIMENSIONS OF SHACKLE END TURNBUCKLES

SIZE A	TAKE-UP B	MINIMUM LENGTH CENTER TO CENTER OF PINS C	DEPTH OF THROAT D	DISTANCE BETWEEN JAWS E	DIAMETER OF PIN F	APPROX. WEIGHT POUNDS	SAFE LOAD IN TONS OF 2000 LBS
1/4	4	7 3/8	3/4	13/32	1/4	.4	1/4
5/16	4 1/2	8 1/2	1	15/32	1/4	.6	1/2
3/8	6	10 3/4	1	9/16	5/16	.9	2/3
1/2	6	12	1 1/4	5/8	3/8	1.8	1 1/4
5/8	6	13 1/4	1 7/16	3/4	1/2	3.1	2
3/4	9	18	1 11/16	15/16	5/8	5.9	3
7/8	12	22 1/4	2 1/8	1	3/4	9	4
1	12	24	2 1/2	1 3/16	7/8	13	5 1/2
1 1/8	12	24 1/4	3 3/8	1 3/4	1 1/8	17	6 1/2
1 1/4	12	26 3/4	3 3/8	1 3/4	1 1/8	22	8 1/2
1 1/2	18	34 7/8	3 7/16	2 1/16	1 3/8	38	13
1 3/4	18	38	4 1/4	2 3/8	1 5/8	66	17 1/2
2	24	47	4 5/8	2 1/2	1 7/8	96	23
2 1/4	24	53	5	2 7/8	2	160	30
2 1/2	24	58	5 1/8	2 7/8	2 1/4	180	37

ASSIGNMENT

Wire Rope Fittings

OBJECTIVE

To be able to recognize various fittings used on wire rope.

TOOLS AND MATERIALS

Thimbles	Shackles
Hooks	Turnbuckles
Links	Slings
Rings	Several sizes of wire rope

PROCEDURE

1. Examine each of the above fixtures.
2. Note the dimensions of each.
3. From the various tables see what size of each of the fixtures should be used for each size of wire rope.
4. Answer the following questions.

QUESTIONS

1. **For what are each of the following used: thimbles, hooks, links, rings, shackle bolts, turnbuckles?**
2. **Why are heavy wire rope thimbles so much heavier than standard wire rope thimbles?**
3. **How is the size of a hook determined?**
4. **What diameter of wire rope is used with a ¾″ hook?**
5. **What diameter of wire rope is used with a 1″ ring?**
6. **How much take-up is there in a 2″ turn buckle?**
7. **Name the two most generally used types of turnbuckles?**

Slings

General Information

Properly designed and fabricated wire rope slings are the safest type of slings. They do not wear away as do slings made of hemp rope, nor do they lose their strength from exposure in the same rapid manner. Neither are they susceptible to the weakest link ailment of chains, caused by the uncertainty of the strengths of the welds. Inspection readily reveals the true condition of wire rope slings. The appearance of broken wires clearly indicates the fatigue of the metal and the termination of the useful life of the sling.

The types of slings most commonly used by riggers are shown below.

Equalizing Slings, as well as some types of Slip-noose Slings and Double-bridle Slings, are made with grommets where endless slings are desired. Grommets are made from one continuous length of strand. The advantage of a grommet over a length of rope spliced endless is that a grommet has but one point of tuck whereas the spliced six-strand rope has six points of tuck. This permits tucking the strand ends the entire length of the grommet, as compared to the much shorter length in the spliced rope.

Fig. 152 — *Eye-End Sling or Pendant*

Fig. 153 — *Fixture-End Sling or Pendant*

Two-Part Equalizing Slings

Two-part Equalizing Slings consist of one endless wire rope grommet and two equalizing thimbles. When these slings are used for lifting rectangular bodies or bodies with corner projections, protective saddles should be specified to protect the rope at the points where it passes around the corners.

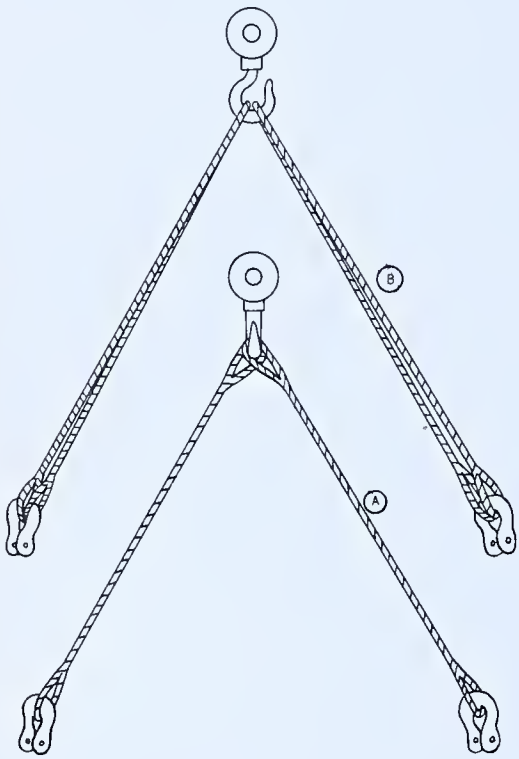


FIG. 154 — *Single and Double Wire Rope Slings or Pendants*

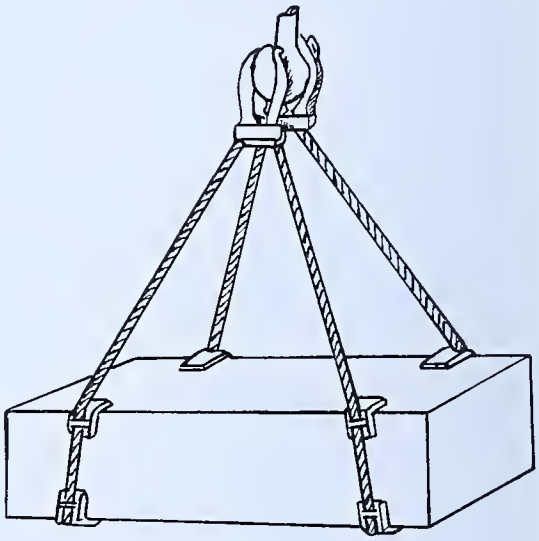
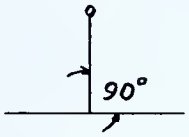
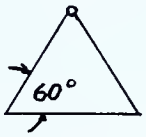
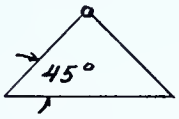
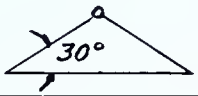


FIG. 154-A — *Two-part Equalizing Sling*

Table XXVII

SAFE LOADS IN POUNDS FOR WIRE ROPE SLINGS
(Loads Specified Must Not be Exceeded)

WIRE ROPE	P. D. SPEC. 3105			
Diameter	Used Straight 	Used at 60° angle 	Used at 45° angle 	Used at 30° angle 
3/8	2050	1750	1450	1000
1/2	3700	3200	2600	1850
5/8	5600	4850	3950	2800
3/4	8050	7000	5700	4000
7/8	10800	9350	7650	5400
1	14000	12100	9900	7000
1 1/8	17600	15200	12400	8800
1 1/4	22000	19000	15500	11000
1 3/8	27200	23600	19200	13600
1 1/2	32000	27700	22600	16000
1 3/4	43200	37400	30500	21600
2	52000	45000	36800	26000
2 1/2	85600	75100	60500	42800
Approx. Fractional Part of "Used Straight" Column.		3/4	2/3	1/2

The safe loads specified in the table are for each wire rope. When used double, or in any other multiple, the load may be increased proportionately. If, for example, the sling has 3 legs, the load may be 3 times the load specified above. Stub hooks may be used with lifting apparatus provided with holes for that purpose.

The safe loads referred to here are based on a 5 to 1 safety factor for use with slings protected by thimbles and hooks. Any increase in the risk involved by sharp edges, short nips, snaring, or other factors of abuse will decrease the factor of safety.

ASSIGNMENT

Using a Sling

OBJECTIVE

To learn to balance a load that is to be lifted with a sling.

TOOLS AND MATERIALS

A chain hoist of suitable size and parts.

A wire-rope sling (eyes in each end).

An object or weight to be lifted.

PROCEDURE

1. Lash the chain hoist to an overhead beam.
2. See that the object to be lifted is blocked up so that the sling can be placed around it.
3. Make sure that the load is balanced.
4. Make the hook of the chain hoist fast to the eyes of the sling.
5. Lift the weight with the chain hoist.
6. Place the sling on the load in as many different ways as possible. Lift different kinds of objects.
7. Answer the following questions.

QUESTIONS

1. **Why should the load be balanced?**
2. **Provided the other lifting equipment is of sufficient strength, how much heavier a load could be lifted by using two slings?**
3. **What is a slip-noose sling?**
4. **How should a hook be fastened to the eye of a sling?**
5. **What is a grommet sling?**

[16]
WIRE ROPE SHEAVE BLOCKS*

General Information

A thorough study of Information Sheet No. 9 — Blocks and Falls — should be made before studying the information given here.

To amplify the use of multiple sheave blocks further and to show the increased power gained in the arrangement of multiple sheave blocks the

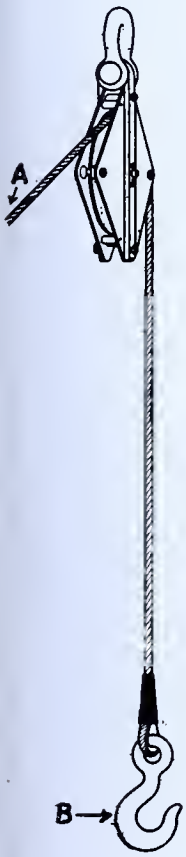


Fig. 155 — *One-part Line*

Fig. 156 — *Two-part Line*

Fig. 157 — *Three-part Line*

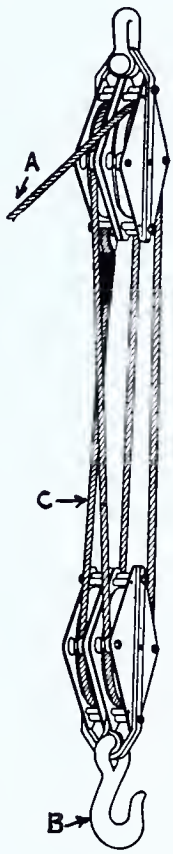


Fig. 158 — *Four-part Line*

A is the hauling part.
B is the load (hook-supported).
C is the standing part.

*Sketches reproduced by permission of the American Steel and Wire Company.

following diagrams are given. It must be remembered that the size and construction of wire rope, diameter of sheaves, score on wire rope grooves, size of sheave pins, and friction at the sheave pins are all factors that reduce efficiency. The sum total of all these inefficiencies increases with the number of sheaves and ranges from 10% to 40%.

A rough formula for estimating the power gained through the use of multiple sheave blocks is to multiply the weight on the hauling part of the purchase by the number of parts of rope between the blocks and subtract a deduction for inefficiency.

A shackle block is stronger than a hook block, and a moused hook is stronger than an open hook.

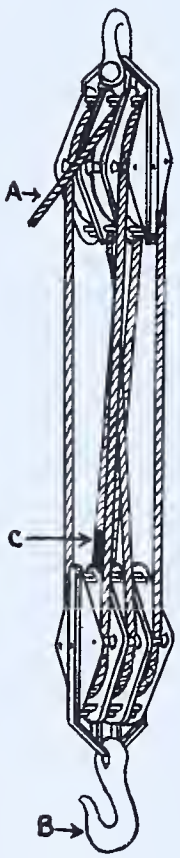


FIG. 159 — *A Five-part Line*

In a one-part line (Fig. 155), the load on the hauling part is theoretically the same as the supported load, that is, disregarding friction loss and inefficiency deductions; but there is always friction where ropes run over sheaves. Accordingly the load on the hauling part must exceed the supported load by an amount sufficient to overcome the friction loss. The amount of friction increases proportionally with the number of parts, or sheaves.

In a two-part line (Fig. 156) the load on the hauling part is one-half the supported load plus friction. In other words the load on the hauling part is more than one-half the supported load.

In a three-part line (Fig. 157) the load on the hauling part is one-third the supported load plus friction.

Likewise in a four-part line (Fig. 158) the load on the hauling part is one-fourth the supported load plus friction.

Similarly, in a five-part line (Fig. 159) the load on the hauling part is one-fifth the supported load plus friction.

Example:

Assuming that the inefficiency of a five-part line is 25%, that the capacity of a power winch is 3800 lbs., and that the breaking or tensile strength of a 3/4" wire rope is 23.7 tons; calculate the amount of load that can be lifted with the winch?

SOLUTION

Breaking strain of wire rope ÷ 5, the safe load for crane wires = The safe load on 1 wire.

23.7 tons ÷ 5 = 4.74 tons = The safe load on 1 wire.

Number of parts of wire between blocks x the safe load for 1 wire = the safe working load for all wires. 5 x 4.74 tons = 23.7 tons.

Allowing 25% for friction

25% of 23.7 tons = 5.9 tons

23.7 tons — 5.9 tons = 17.8 tons, or the safe working load on the tackle.

ASSIGNMENT

Sheave Blocks

OBJECTIVE

To learn the functions of various sizes of sheave blocks.

TOOLS AND MATERIALS

Sheave blocks from 1-part line to 5-part line.

Wire rope with hook attached.

Wire rope with eye in one end.

PROCEDURE

1. Lash the upper block to an overhead beam.
2. Make up a one-part line.
3. Make up a two-part line.
4. Make up a three-part line.
5. Make up a four-part line.
6. Make up a five-part line.
7. Answer the following questions (disregard friction).

QUESTIONS

1. With a one-part line, how much power is gained?
2. With a two-part line, how much load must be exerted to lift one ton?
3. With a three-part line, how much load must be exerted to lift three tons?
4. With a four-part line, how much load will be required to lift one ton?
5. With a five-part line, how much will one ton lift?

[17]
CHAINS AND CHAIN HOISTS*

Material for Crane Chains

General Information

The best material for crane and hoisting chains is a good grade of wrought iron, in which the percentage of phosphorus, sulphur, silicon, and other impurities is comparatively low. The tensile strength of the best grades of wrought iron does not exceed 46,000 pounds per square inch, whereas mild steel with about 0.15 per cent carbon has a tensile strength nearly double this amount. The ductility and toughness of wrought iron, however, is greater than that of ordinary commercial steel; and for this reason it is preferable for chains subjected to heavy intermittent strains, because wrought iron will always give warning by bending or stretching, before breaking. Another important reason for using wrought iron in preference to steel is that a perfect weld can be effected more easily.

Strength of Chains

When one is calculating the strength of chains, it should be observed that the strength of a link subjected to tensile stresses is not equal to twice the strength of an iron bar of the same diameter as the link stock, but is a certain amount less, owing to the bending action caused by the manner in which the load is applied to the link. The strength is also reduced somewhat by the weld. The following formula is commonly used for calculating the breaking load, in pounds, of wrought-iron crane chains:

$$W = 54{,}000D^2$$

in which W = breaking load in pounds, and D = diameter of bar (in inches) from which links are made. The working load for chains should not exceed one-third the value of W; in many cases, it is one-fourth or one-fifth the breaking load. When a chain is wound around a casting and severe bending stresses are introduced, a greater factor of safety should be used.

*This information was taken from Machinery's Handbook, 11th Edition, and from material furnished by the Yale and Towne Manufacturing Company.

Care of Hoisting and Crane Chains

All chains used for hoisting heavy loads are subject to deterioration, both visible and invisible. The links wear, and there is also an alteration in the nature or fiber of the material, owing to the strains, shocks, etc., which produce crystallization. Chain wear can be reduced considerably by occasional lubrication. The life of a chain can also be prolonged by frequent annealing, because annealing restores the quality of the material to some extent, although there may be a slight decrease in the tensile strength.

Annealing a Chain

To anneal a chain, heat it to a cherry-red and allow it to cool slowly. This should be done every six months, and oftener if the chain is subjected to unusually severe service. Chains should be examined periodically for twists. A twisted chain will wear rapidly. Any links which have worn excessively should be replaced with new ones, so that every link will do its full share of work during the life of the chain without exceeding the limit of safety. Chains for hoisting purposes should be made with short links, so that they will wrap closely around the sheaves or drums without bending. The diameter of the winding drums should be not less than 25 or 30 times the diameter of the iron used for the links.

Loads Lifted by Crane Chains

To find the approximate weight a chain will lift when rove as a tackle, multiply the safe load given in Table XXVIII "Close-link Hoisting, Sling, and Crane Chain" by the number of parts or chains at the movable block, and subtract one-fourth for frictional resistance. To find the size of chain required for lifting a given weight, divide the weight by the number of chains at the movable block, and add one-third for friction: next find in the column headed "Average Safe Working Load" the corresponding load, and then the corresponding size of chain in the column headed "Size". In case of heavy chain or where the chain is unusually long, the weight of the chain itself should also be considered.

Close-Link Hoisting, Sling, and Crane Chain

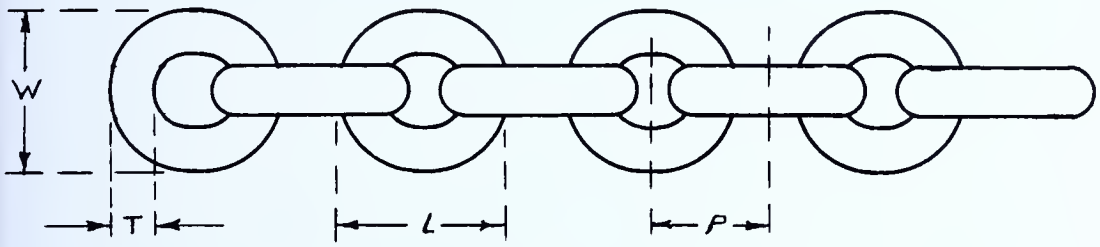


FIG. 160

Table XXVIII

DIMENSIONS AND SAFE LOADS FOR CLOSE-LINK CHAINS

Size T	Standard Pitch P	Average Weight per foot in pounds	Outside Length L	Outside Width W	Average Safe Working Loads in Pounds			
					Used Straight (90°)	Used at 60° Angle	Used at 45° Angle	Used at 30° Angle
3/8	31/32	1 1/2	1 3/4	1 1/4	2,500	1,875	1,667	1,250
1/2	1 11/32	2 1/2	2 3/8	1 11/16	4,500	3,375	3,000	2,250
5/8	1 23/32	4	3	2 1/16	6,700	4,025	4,367	3,850
3/4	1 15/16	6 1/4	3 1/2	2 1/2	10,000	8,500	6,667	5,000
7/8	2 3/16	8	4	2 7/8	12,000	9,000	8,000	6,000
1	2 1/2	10	4 5/8	3 1/4	15,200	11,400	10,134	7,600
1 1/8	2 3/4	13	5 1/8	3 3/4	19,500	14,625	13,000	9,750
1 1/4	3 1/8	16	5 3/4	4 1/8	23,700	17,775	15,800	11,850
1 3/8	3 9/16	19	6 7/16	4 9/16	28,500	21,375	19,000	14,240
1 1/2	3 7/8	23	7	5	33,500	25,125	22,434	16,750
1 3/4	4 3/4	31	8 1/2	5 7/8	41,500	31,125	27,667	20,750
2	5 3/4	40	10	6 3/4	54,000	40,500	36,000	26,000
2 1/2	7	65	12 1/4	8 3/8	84,200	63,150	56,134	42,100
						3/4	2/3	1/2

The safe loads specified in the table are for each single chain. When used double, or in any other multiple, the load may be increased proportionately. If, for example, the sling has 3 legs, the load may be three times the load specified above. Stub hooks may be used with lifting apparatus provided with holes for that purpose.

Chain Hoists

General Information

Chain Hoists are used in other ways than lifting a load, such as hauling the tail shaft in and out of the stern tube where air power is supplied by the use of a corner machine with adapters to do the hauling.

Most rigging jobs require the use of a crane and chain hoists arranged to receive the piece of equipment being installed. The arrangement of this equipment should be made in advance and should be of sufficient strength to carry the load safely.

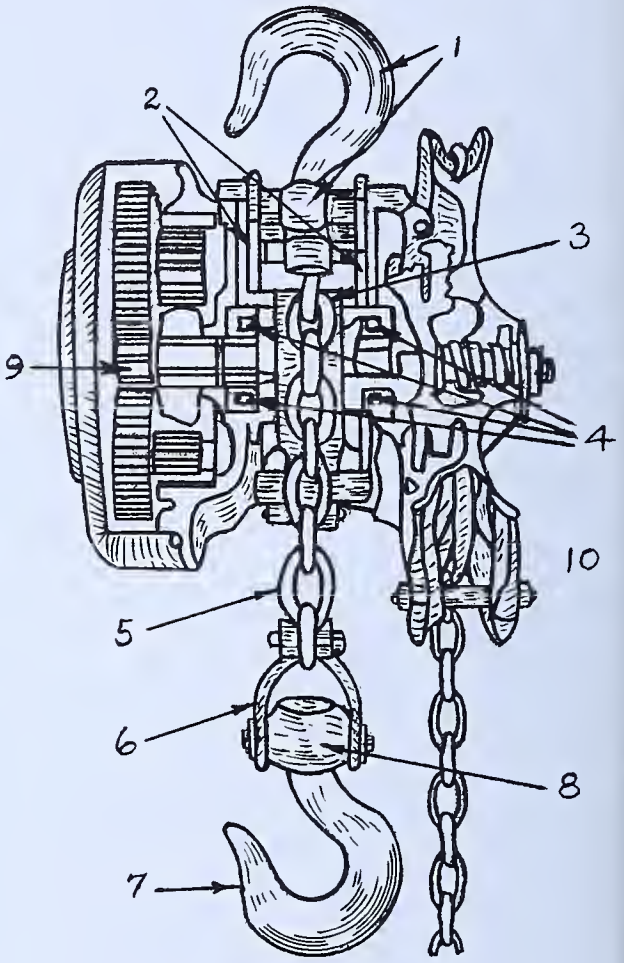


Fig. 161 — *The Parts of a Spur-Geared Chain Hoist*

1. Steel Safety Hook and Crosshead are heavy steel forgings designed to withstand shock and surge loads of several times their rated capacity. These permit free swiveling and rocking action.
2. Steel Suspension Plates are wrought-steel plates that support the load between the top hook crosshead and load sheave.
3. Steel Load Sheave is the load sheave on which the suspended load is lifted. It is a massive, special-analysis steel casting.
4. Ball Bearings. The load sheave is mounted on two ball bearings, radial thrust type, using high carbon, chrome alloy steel balls running in chrome vanadium steel races.

5. Steel Load Chain is made exclusively of steel. It is formed, welded, heat-treated, tumbled, and gauged by a controlled process that provides the following physical characteristics:

    1. The necessary ductility and toughness to withstand heavy intermittent loads, and the characteristics whereby it will stretch before breaking.

    2. Uniformity as to size, with all links gauged on master gauges for accuracy of pitch and over-all dimensions.

    3. A minimum strength at the weld equal to the ultimate strength of the chain.

6. Steel Detachable Shackles are drop-forged two-piece shackles with heat-treated suspension pin which permits changing or replacing load chain without welding.

7. Steel Safety Hook is the "safety valve" of the hoist. It is drop-forged from special steel; it opens slowly, without fracture, before any other part of the block is overstressed; and protects the mechanism, the load, and the workmen.

8. Ball Bearing for Steel Safety Hook. The lower hook is equipped with a heavy-duty ball bearing which is totally enclosed against dirt, dust, water, or other foreign matter. It is packed in grease at assembly and requires no further lubrication during the life of the hoist.

9. Steel Driving Pinion. The driving pinion is a one-piece forging of special steel to resist extraordinary twisting and bending. It is heat-treated and ground to a thousandth of an inch.

10. Hand Chain Guide. A continuous and adjustable, hand chain guide prevents snagging and fouling of hand chain. This guide is made of tough, malleable iron having a tensile strength of 50,000 pounds.

Types of Chain Hoists

Table XXIX

BALL-BEARING, SPUR-GEARED CHAIN HOISTS

This type of hoist possesses the maximum mechanical efficiency obtainable in any chain-hoist mechanism.

Rated Capacity Long Tons (2240 Lbs.)	Travel of Lower Hook of Standard Lift, in Ft.	Test Load in Long Tons	Minimum Distance Between Hooks in Inches	Weight in Lbs. Net	Chain Pull to Lift Fall Load in Lbs.	Chain Overhauled to Lift Load One Foot in Feet
10	12	15	54	612	132	210
20	12	30	62	1230	132	210*

*For each hand chain.

Table XXX

SCREW-GEARED CHAIN HOISTS

This type of hoist is a companion to the spur-geared chain hoist. It is designed for work of a lighter nature, and is serviceable where high-speed action is not necessary. It operates on a worm-gear reduction and holds the load in any position. It will not lower unless the hand chain is pulled.

Rated Capacity in Long Tons of 2240 Lbs.	Regular Lift in Ft.	Minimum Distance Between Hooks in Inches	Chain Pull to Lift Full Loads in Lbs.	Chain Overhauled to Lift Load One Ft. in Feet	Net Weight in Pounds
½	8	14	68	40	46
1	8	16	87	59	60
3	10	25	132	126	187

When to Use Chain Hoists Instead of Blocks and Falls

In making a choice between using chain hoists or blocks and falls the rigger must consider several items. For light loads, blocks and falls are generally used, and for heavy loads chain hoists may be used. The number of sheaves and the number of blocks are factors to consider in the selection.

Chain hoists are limited as to length of lift. A one-ton chain hoist generally has a lifting span of ten feet. This varies according to the capacity of the chain hoist.

Very often the working space is limited; so various methods of handling equipment have to be resorted to. For long lifts blocks and falls are generally used.

Whenever possible a crane should be used. It not only saves time, but it is handier and far safer.

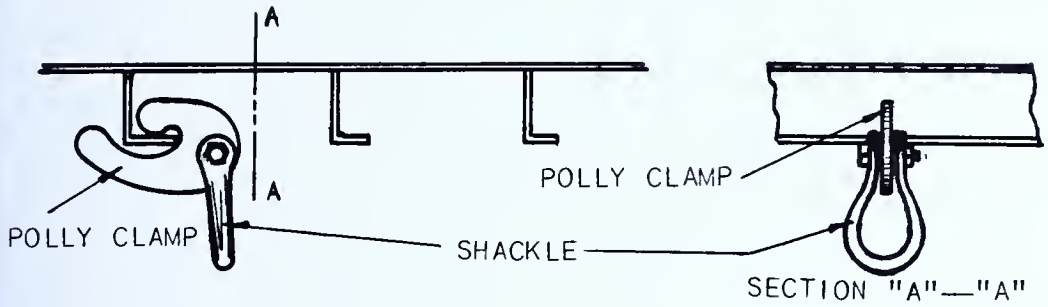


FIG. 162 — *Polly Clamp*

How to Lash a Chain Hoist

When the rigger is lashing a chain hoist, he must take several things into consideration. If the load to be lifted is light, a Manila-rope lashing may be used. It should be wrapped loosely a sufficient number of turns around an overhead beam, put through a ring. and then tied with a square knot. The ends of the rope should be seized, and a seizing should be placed around the knot. Place old burlap under any sharp corners in order to prevent cutting the rope. Sometimes pieces of wood battening are used to protect the surface of the beam. Care must be taken not to let the different parts of the lashing overlap, for overlapping puts all the load on one part.

Sometimes there is no overhead beam available or the lashing cannot be put around the beam; in such an event one might have to use welded eyes, pads, beam clamps, or polly clamps.

At times two or more chain hoists will have to be used; the overhead clearance and the height the load is to be lifted, however, will have to be taken into consideration.

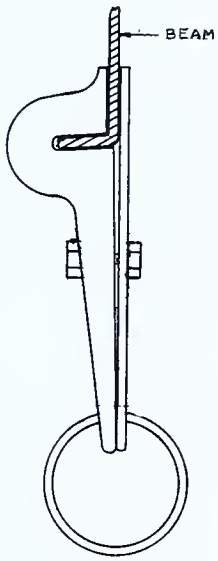


FIG. 163 — *Beam Clamp. May be used in handling loads up to 7 or 8 tons according to the strength of the beam.*

When heavy loads are to be lifted, wire rope is used for the lashing. It is wrapped around the beam with blocking and padding to protect the beam and the rope. In some cases a wire-rope pendant can be used if the clearance is sufficient.

When tying a wire rope lashing, use a square knot. When it is half tied place a wire seizing around the knot and another seizing around the completed knot. Lash the ends of the rope to the rest of the rope (with a wire seizing).

No specific procedure can be given for lashing a chain hoist because of the many items that must be considered. Good judgment must be exercised, and careful consideration must be given to the capacity of the chain hoist as well as to the safe load of the cable.

ASSIGNMENT

The Use of Chain Hoists

OBJECTIVE

To learn how to lash a chain hoist.

TOOLS AND MATERIALS

A Manila-rope lashing	Alligator clamps
A wire-rope lashing	Polly clamps
A chain hoist	Beam clamps
Seizing wire and yarn	Ring

PROCEDURE

1. Lash a Manila rope and a ring to an overhead beam. Parcel the rope around the beam.
2. Hook the chain hoist to the ring.
3. Lift some light load.
4. Use a wire-rope lashing, and proceed as above according to the information sheet.
5. Answer the following questions.

QUESTIONS

1. **What are the important parts of a chain hoist?**
2. **Name the two types of chain hoist most commonly used.**
3. **Why should seizings be put on a wire-rope square knot?**
4. **For what are polly clamps used? Beam clamps?**
5. **When are wire-rope lashings used in place of Manila-rope lashings?**

[18]

JACKS

Types of Jacks Used by Riggers

Only Jacks Especially Suited for Riggers' Work Are Listed

FIG. 164 — *Jacks*

A few of the different jacks that are used around a shipyard.

1. Screw Jack — 25 tons capacity with horizontal ratchet-handle control.
2. Bell-Bottom Screw Jack — 10 and 15 tons capacity, with four-way head control.
3. Ball-Bearing Locomotive and General-Purpose Jack — With or without foot lift provided. 25 tons capacity with vertical ratchet-handle control.
4. Journal Jack — Low-height, Ball-Bearing Screw Jack. 25 tons capacity, with vertical ratchet-handle control.
5. Bridge and Wrecking Jack — Low-Height, Ball-Bearing Jack. 35 and 50 tons capacity, with vertical ratchet-handle control.
6. Journal Jack — Low-Height, Ball-Bearing Screw Jack. 25 and 35 tons capacity, with vertical ratchet-handle control.
7. Bridge and Wrecking Jack — Ball-bearing with foot lift provided. 50 tons capacity, with speed-controlled, self-lowering arrangement.

Self-Lowering, Speed-Controlled, Foot-Lift Jacks

These jacks are equipped with foot lift for handling low-set loads. They are especially suited for general lifting purposes. The foot lift of any jack may be used at 50% of capacity.

Table XXXI

JACKS — SEE FIG. 164 — 5 and 7

Capacity in Tons	Height Inches	Rise Inches	Diameter of Base Inches	Weight in Lbs.
35	26	13¾	12	196
50	26	14	14	275

Journal Jacks

Low Height Ball-Bearing Screw Jacks

This type of jack is designed for lifting and adjusting low-set loads such as tanks, structural material, etc. The built-in positive stop feature prevents raising standard out of base. These jacks combine unusually light weight with ample strength for their rated capacities. A key in the standard prevents rotation of the jack under load and preserves the alignment of the working parts.

Table XXXII

JACKS — SEE FIG. 164 — 2

Capacity in Tons	Height in Inches	Rise — Inches	Weight in Lbs.
25	10	5	36

Ball-Bearing Journal Jacks

These jacks are particularly adaptable to many purposes requiring low jacks for short lift. They are lightweight and easy to operate.

Table XXXIII

JACKS — SEE FIG. 164 — 4

Capacity — Tons	Height — Inches	Rise — Inches	Weight — Lbs.
25	10	5	36

Ball-Bearing Bridge and Wrecking Jacks, Foot-Lift Type

These jacks are especially suitable for rough outdoor work. The foot lift, which is rated at half the capacity of the jack, is very convenient for handling low loads. These jacks are designed for heavy duty, such as the handling of heavy machinery.

Table XXXIV

JACKS — SEE FIG. 164 — 3

Capacity Tons	Height Inches	Rise Inches	Diameter of Base Inches	Weight Lbs.	Safe Load for Foot Lift — Tons
25	22	10¼	8 x 9¾	140	12½

Locomotive Screw Jacks

Cast-Steel Base

This type of jack is in common use, and its construction makes possible the lifting of very heavy loads.

Table XXXV

JACKS — SEE FIG. 164 — 1

Capacity Tons	Diameter of Screw Inches	Height of Stand Inches	Closed Height Over-all Inches	Rise Inches	Diameter of Base Inches	Weight Lbs.
25	2½	20	19	10	10	75

All jacks shown are made in various sizes and capacities. Only the ones commonly used by riggers are shown.

The principle of the screw jack is that of the inclined plane in the form of a screw with a swivel head.

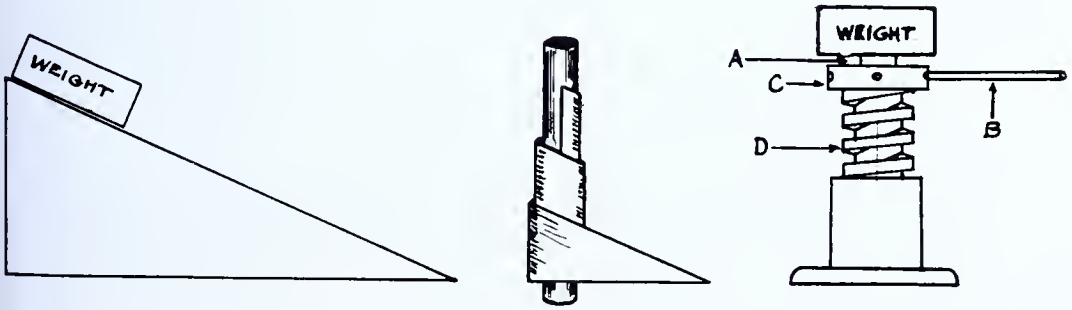


FIG. 165

The screw jack is nothing more than an adaptation of the inclined plane in the form of a screw.

A. Swivel head to prevent twisting the load. See Fig. 165.

B. Steel Bar for turning "C" which is threaded on the inside.

D. The screw which raises or lowers the load as "C" is turned.

ASSIGNMENT

Jacks

OBJECTIVE

To learn the principle of the screw.

TOOLS AND MATERIALS

Several sizes of jacks.

Paper, pencil, and scissors.

PROCEDURE

1. Study the information carefully.
2. Examine the various sizes of jacks and note the capacity of each.
3. Cut a right triangle out of paper; make one leg of the triangle 10 inches long and the other 3 inches.
4. Mark the hypotenuse with a black line.
5. Wrap the triangular paper around a pencil, keeping the 10″ side at one end of the pencil.
6. Answer the following questions.

QUESTIONS

1. **What type of mechanism is a screw jack?**
2. **What are some of the uses of the jack?**
3. **What weight of load can be lifted with the foot lift of a jack as compared to the actual capacity of the jack?**
4. **What figure was formed by the black line when the paper triangle was wrapped around the pencil?**

[19]
TYPES OF CRANES
1. Storeroom Electric Crane

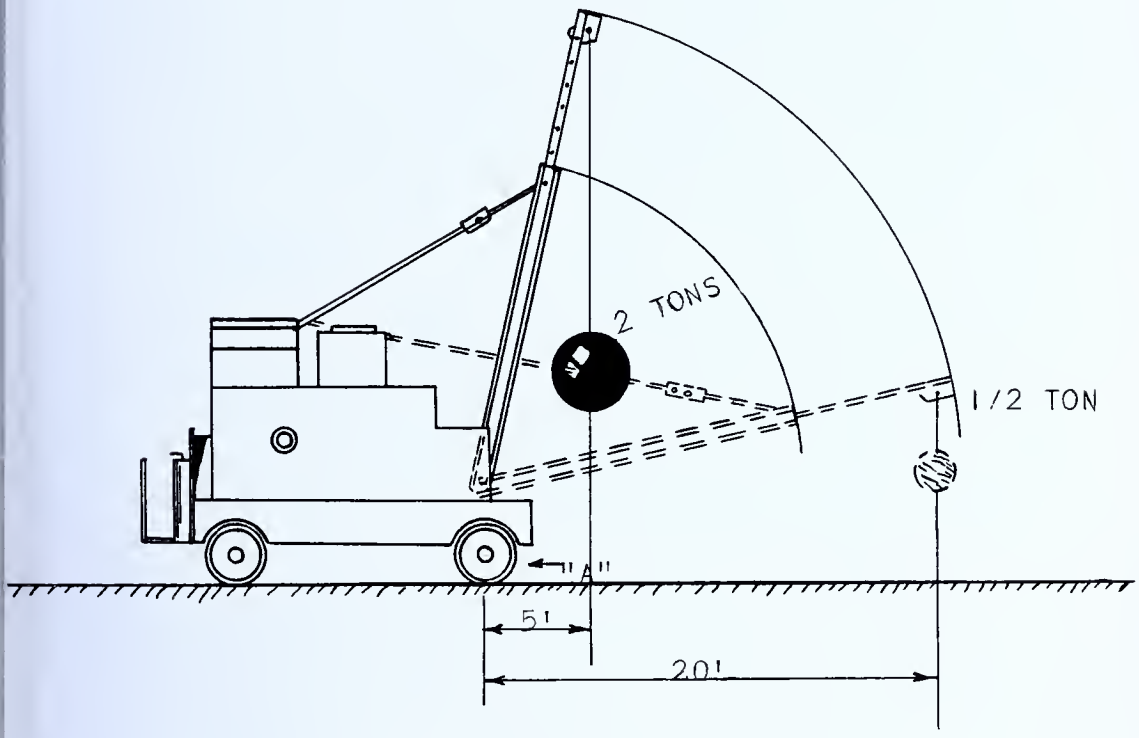


FIG. 166 — *Storeroom Electric Crane*

NOTE: When blocked at "A" the maximum lift is two tons, but the crane cannot be moved.

This crane may be mounted on the old-type electric truck with a boom that has adjustable lengths up to approximately 20 feet.

This kind of crane may be used for the lifting and transporting of light loads up to 2 tons. Due regard must be given to the type of ground and elevation of the boom. Both of these factors alter the capacity of the crane. This crane is used principally for unloading trucks and cars, and for moving and storing light loads where other cranes are not available.

2. Locomotive Steam Crane

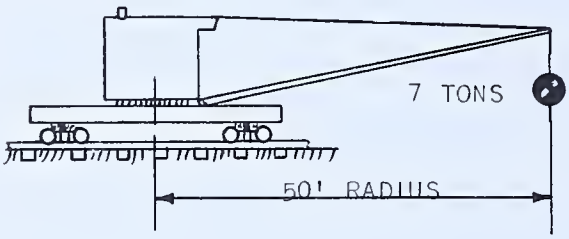


Fig. 167

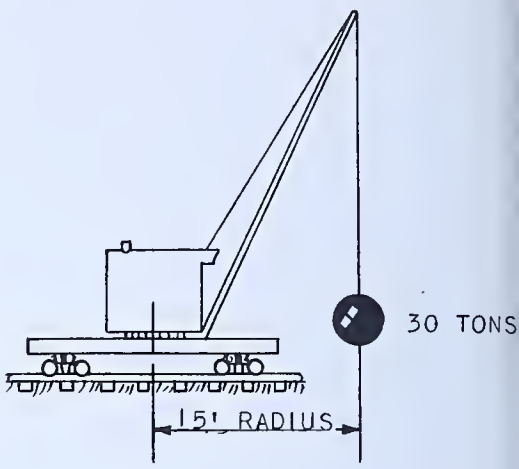


Fig. 167-A

Locomotive Steam Cranes have various capacities which are marked on the side of the cab in lbs. or tons at the different boom radii. You will note in Figs. 167 and 167-A that the crane boom is straight ahead.

In Figs. 167-B and 167-C the boom is at the side, and the lifting capacity is only about half the straight-ahead capacity.

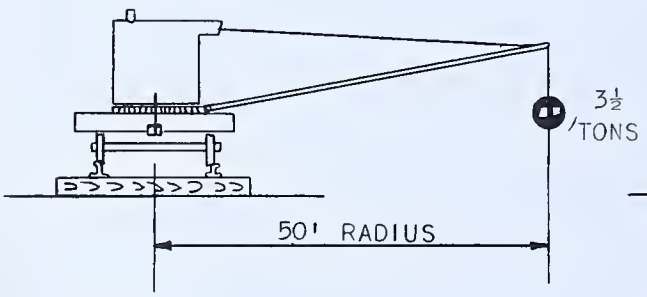


Fig. 167-B

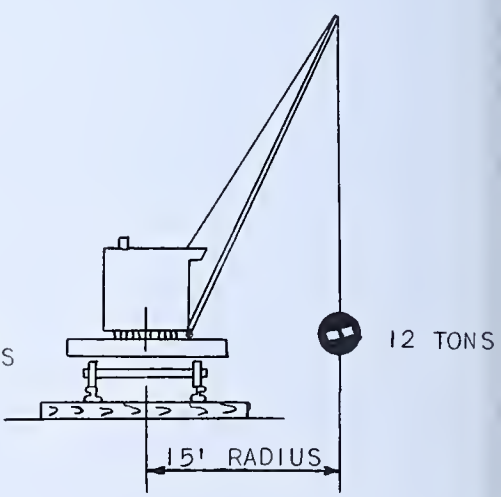


Fig. 167-C

When outriggers and rail clamps are used, the capacity is greatly increased as shown in Figs. 167-D and 167-E.

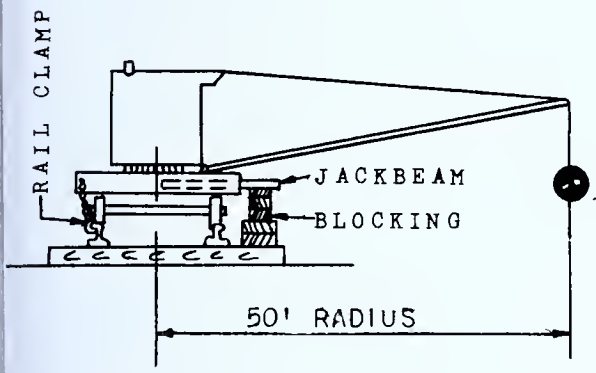


FIG. 167-D

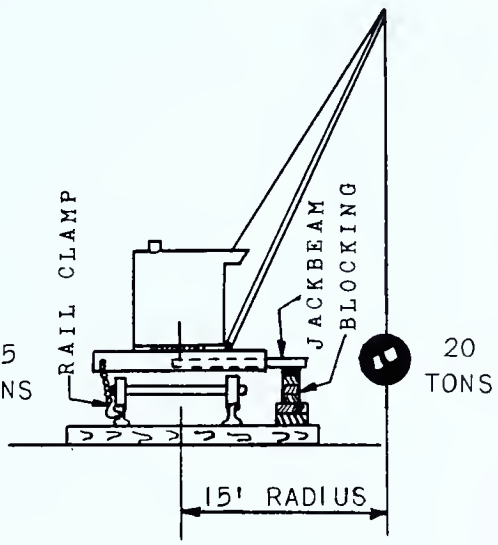


FIG. 167-E

Observe closely that the crane capacity on swinging a load to the side, even with a high boom, is very limited. In most cases the crane's side capacity can be increased considerably by means of jack beams (outriggers), blocking, and rail clamps.

Great care must be exercised not to swing these questionable overloads too fast. The exercise of this precaution gives the rigger and crane man a chance to check the load.

In handling any load where outriggers are to be used, the crane man must locate the crane carefully abreast of the point where the load will be landed because the crane will not be able to travel after it begins to rest on the blocking.

The handling of any questionable load by the rigger should be discussed and planned with the crane leader and the crane operator.

Careful attention should be given to the condition of the track, the ground beneath, the load, and the topping-lift wires. Also the brakes should be checked before handling any load.

3. Caterpillar Crane

Caterpillar cranes have various capacities as shown on the side of the cab. This crane is most efficient when the load is straight ahead.

The crane has greater capacity on the side than the steam crane, but still not up to 100% of capacity. Questionable loads should be walked by lower-

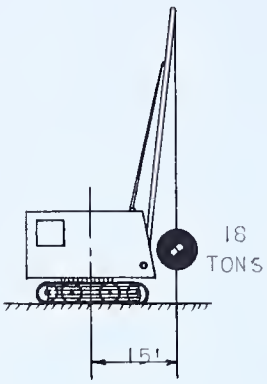


Fig. 168

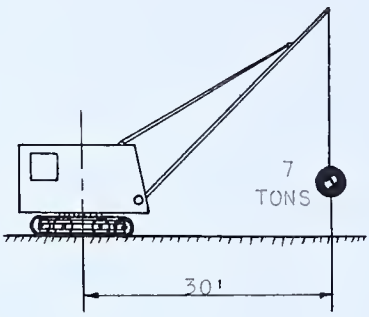


Fig. 168-A

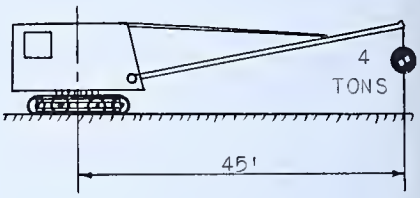


Fig. 168-B

ing the boom, releasing the load, advancing on the load, lifting the load on a high boom, lowering the boom, lowering the load, and repeating this process until the load is in proper position.

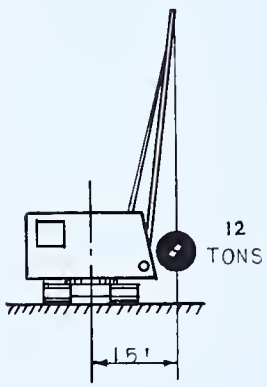


Fig. 168-C

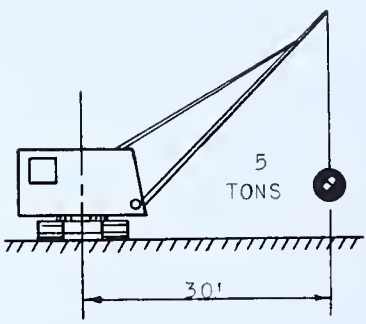


Fig. 168-D

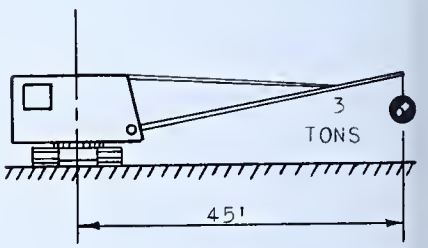


Fig. 168-E

The ground in front of the crane should be either hard or covered with planking. Great care should be taken when using caterpillar cranes to keep the load as close to the ground as practical in order that the load may be released if the crane should start to turn over. The manner of handling a load with this type of crane should be discussed by the riggers with the crane leader and crane operator.

4. Gantry Crane

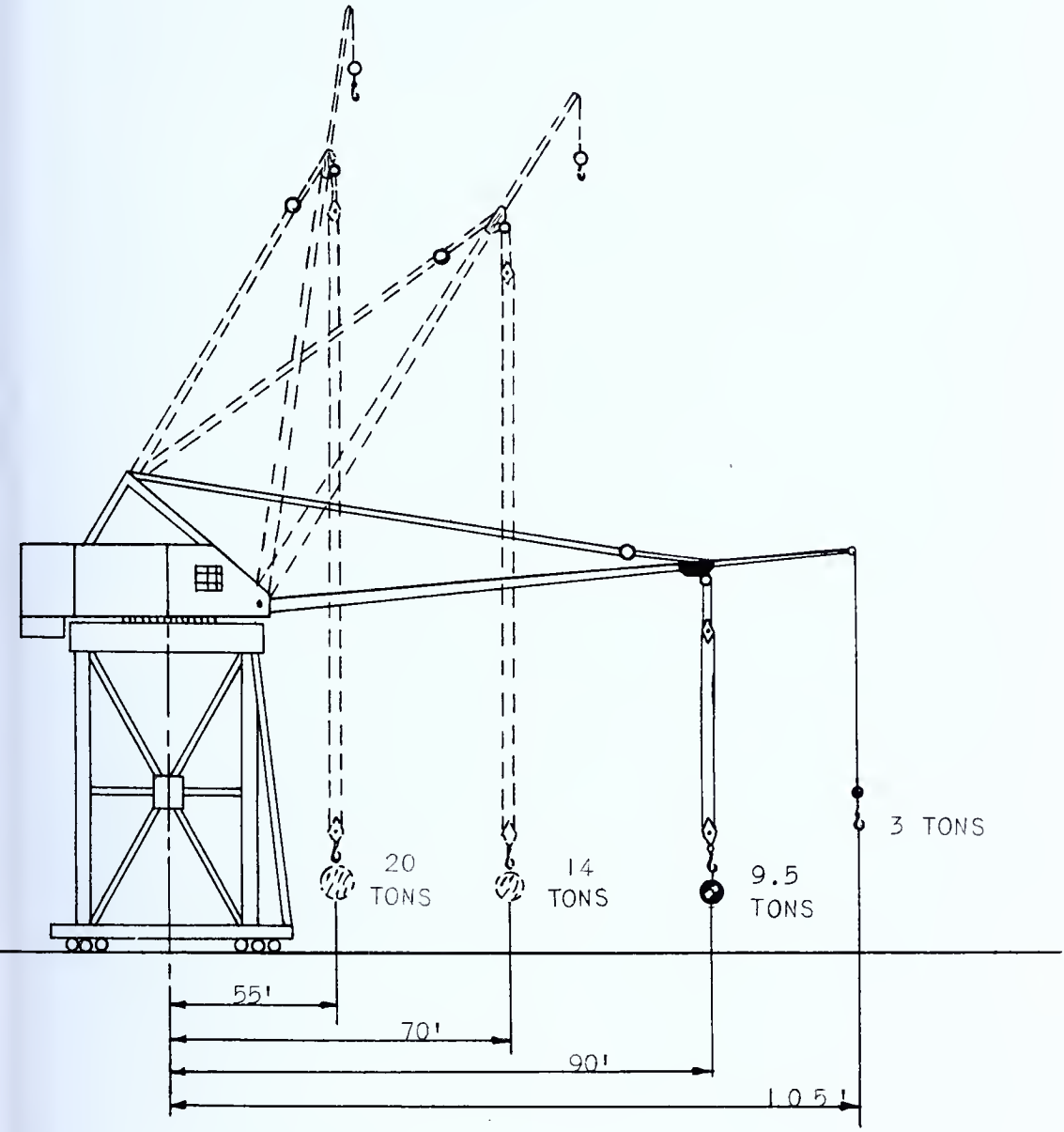


FIG. 169— *Gantry Crane*

Many shipyards are equipped with gantry cranes. These cranes have light nd heavy hoists with the capacities of each marked on the crane. Unlike ocomotive and caterpillar cranes, the gantry cranes have full capacity in winging loads through 360°, or a complete circle.

The gravest danger that may arise in using gantry cranes comes when heavy loads are swung with the boom set on a low radius. Any questionable load should be handled and travelled up and down the tracks with a high boom or a short radius. The load should be put as close as possible to the foundation on which it is to be set, then slowly worked into place by lowering the boom, raising the load on the hoist, and repeated operations of lowering the boom and raising the load.

During these extensions of the boom radius, great care must be exercised; a man with a whistle should be stationed to watch the rear wheels of the crane and instructed to signal a warning if they are raised from the track. When this happens it means that the handling limit of the crane has been reached.

5. Heavy-Lift Gantry Crane

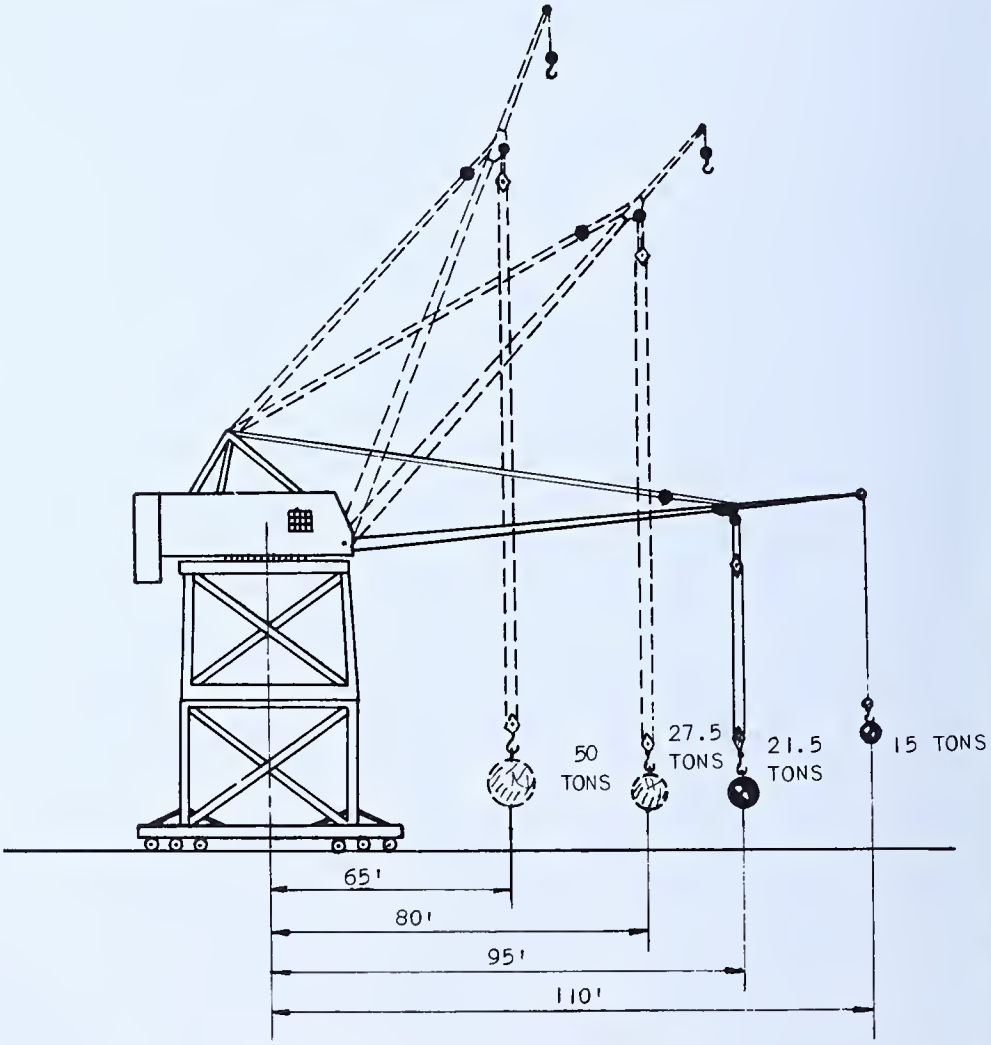


Fig. 170 — *Heavy-lift Gantry Crane*

6. Overhead Crane

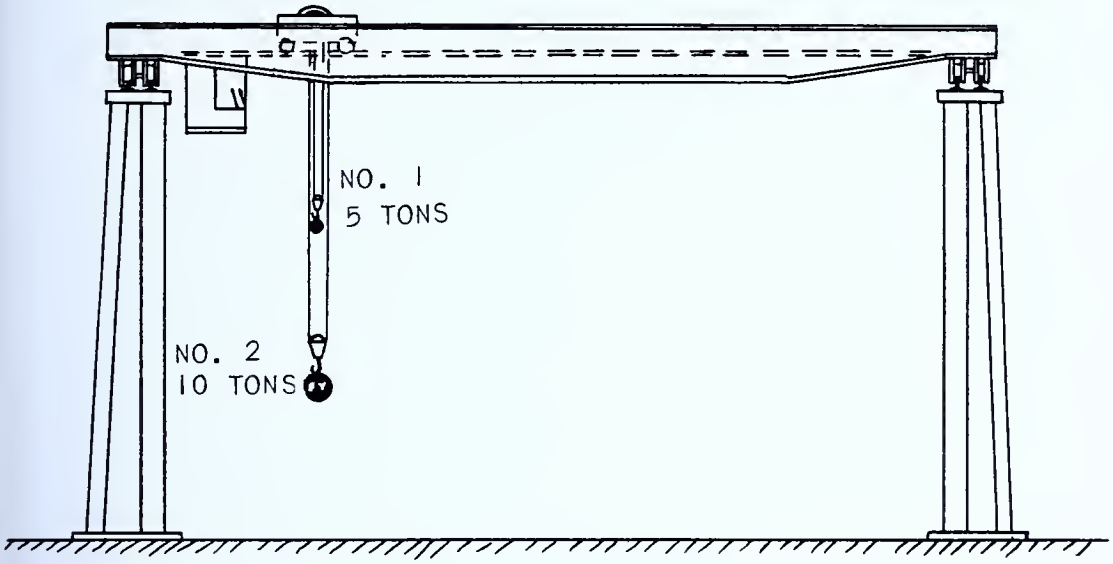


Fig. 171 — *Overhead Crane*

Overhead cranes have great overload capacities which vary according to the condition of the operating equipment. Their capacities are marked on the crane girder; and, while these capacities may be exceeded, care should be exercised by the riggers to inspect crane wires and have the electric and crane-maintenance departments present when overloads are made. Probably the weakest point in overhead-crane operation is the adjustment of the magnetic brake which the crane operator may have to adjust.

7. Hammerhead Crane

In the hammerhead type of crane there is a movable trolley on a swinging horizontal boom with main and auxiliary hoists. The heaviest safe loads handled by the main hoist of the hammerhead crane range from 65 tons at the end of the boom to 150 tons in close to the crane tower. The light hoist of the hammerhead crane is limited to about 12 tons safe load, although the hoist is supposed to be rated at 20 tons.

This inefficiency of auxiliary hoist capacity is due to brake trouble caused by overloads made years ago. Particular caution should be exercised in the use of this crane's auxiliary hoist because of this weakness.

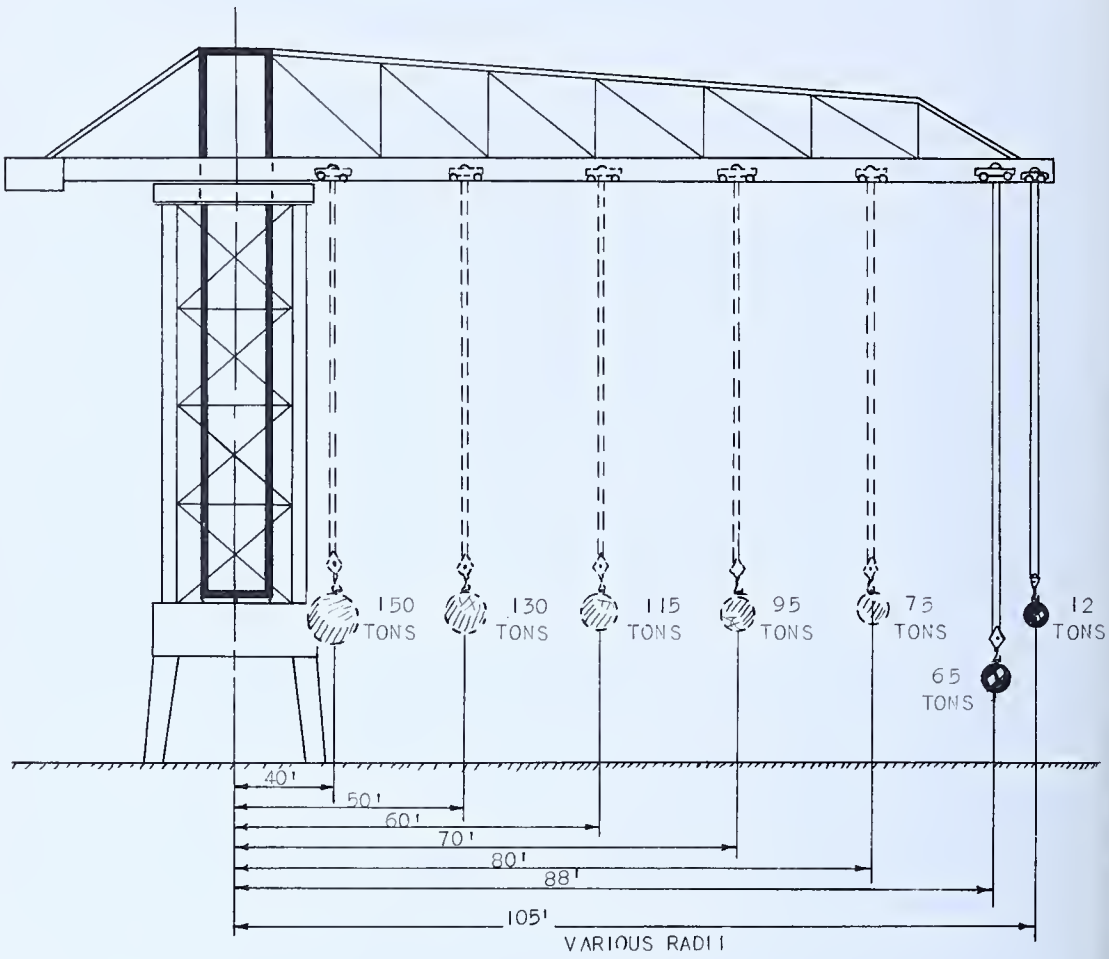


FIG. 172 — *Hammerhead Crane*

The hammerhead crane is used for engine, shafting, generator, windlass, smokestack, and boiler installation in ships. Other miscellaneous jobs for the hammerhead crane are the loading of castings on annealing furnace cars, reloading these castings for shipment, and handling heavy refining units.

This crane is slow, but it is particularly adaptable to the handling of heavy loads.

When, due to the excessive height of a ship, the crane hoist has to be used above the limits of hoist allowed by the limit switch, electricians must be notified and sent to the crane to help the operator.

Safety Precautions

Avoid sudden stops in lowering loads.

Have the hoist located over the load before lifting. Use a tag line or heaving line to prevent loads from swinging.

DO NOT LET CRANES TRAVEL TOO FAST.

Be sure the tracks are clear.

Keep a high boom on gantry, caterpillar and steam cranes when handling excessive loads.

Do not fill crane hooks with too many parts of wire or Manila rope as this will throw the weight of the piece being lifted to the lip instead of the axis of the hook.

Do not permit cranes to swing questionable or heavy loads in a fast or careless manner.

The illustrations and advice given here are general in scope and can be of help only when used advisedly and with care.

In all cases of questionable loads the riggers, crane operator, and crane leader should plan the procedure for handling the load. The safest method

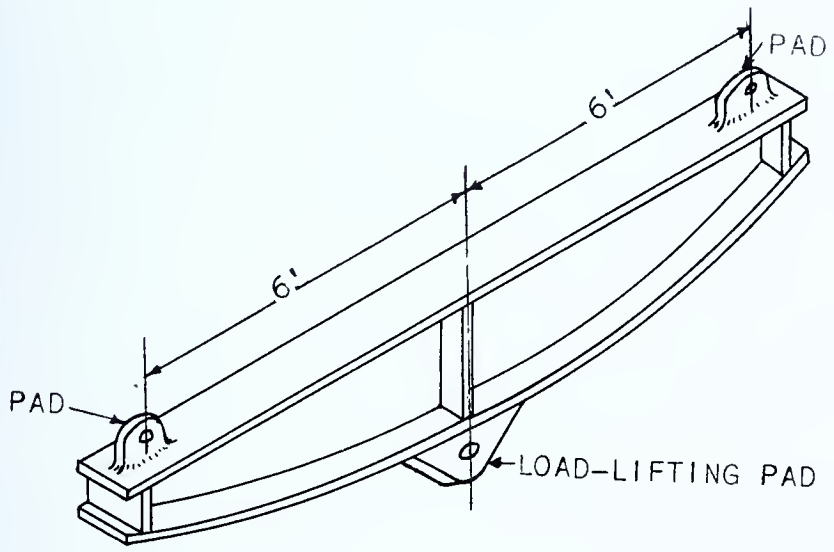


FIG. 173 — *Small Equalizing Bar*

must be determined to the satisfaction of all concerned and only after proper consideration has been given to wires, boom, crane mechanism, and the ability of the operator.

Equalizing Bars

A small equalizing bar is of 30-ton capacity, has a spread of 12 feet, weighs 1200 lbs., and is so designed as to keep crane booms and auxiliary hoists apart. The lifting pads are arranged so as to place the same load on each of two cranes of the type generally used for work about the piers.

A large equalizing bar is of 60-ton capacity. It has a spread of 26′ and weighs 5½ tons. The load-lifting pads and shackles are off center so that the heavier crane may carry the heavier load. The load-lifting eye is 10′ 8″ from one lifting pad and 15′ 7½″ from the other.

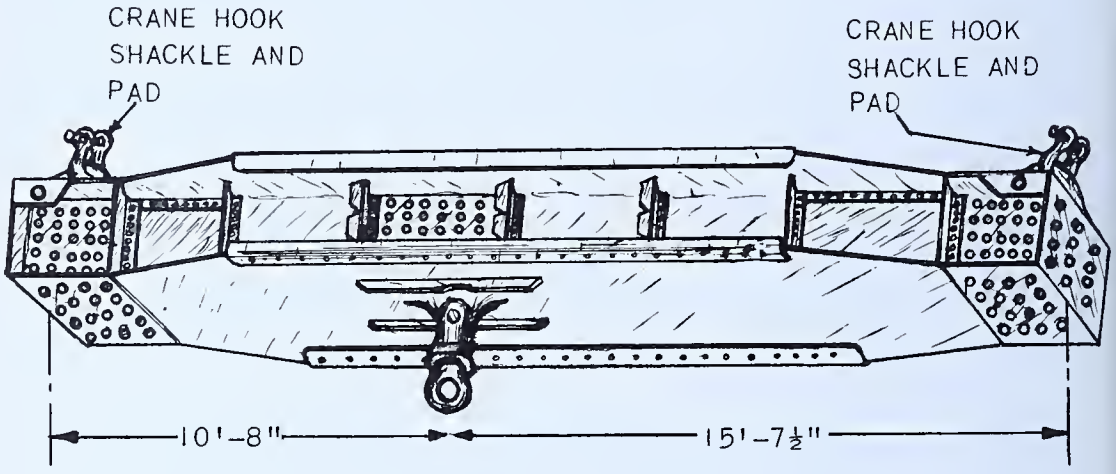


Fig. 174 — *Large Equalizing Bar*

ASSIGNMENT

Types of Cranes

Objective

To become familiar with the capacities of various types of cranes.

Procedure

1. Study carefully the information on cranes.
2. Answer the following questions.

QUESTIONS

1. What size of loads can be lifted with the storeroom electric crane?
2. What are outriggers and for what are they used?
3. Why is the caterpillar crane most efficient when lifting loads that are straight ahead?
4. When using a caterpillar crane why should the operator keep the load close to the ground?
5. When using a gantry crane why should the operator put the load as close to the foundation as possible?
6. When lifting a questionable load, how can one determine when the handling limit of a gantry crane is reached?
7. What is probably the weakest point in the operation of an overhead crane?
8. What is a tag line?
9. For what is a hammerhead crane used?
10. Why should crane hooks not be filled with too many parts of wire or Manila rope?

[20]
ESTIMATING WEIGHTS

General Information

For the purpose of aiding the rigger to estimate the weights of various pieces of equipment which he may have to handle, the following tables have been arranged.

Table XXXVI

WEIGHT — AVOIRDUPOIS OR COMMERCIAL

437.5 grains	= 1	ounce (oz.)
16 ounces	= 1	pound (lb.)
112 pounds	= 1	hundredweight (cwt.)
20 hundredweight	= 1	gross, or long ton (2240 pounds)
2000 pounds	= 1	net, or short ton (T)
2204.6 pounds	= 1	metric ton

Table XXXVII

WEIGHTS OF SQUARE AND ROUND STEEL BARS IN POUNDS PER FOOT

Dia. of Round or Side of Square in Inches	Weight in Pounds per Foot	
	Square	Round
8	217.6	170.9
10	340.0	267.
12	489.6	384.5
14	666.4	523.32
16	870.4	683.6
18	1101.6	865.08
20	1360.	1068.
24	1958.4	1538.
28	2665.6	2093.28
32	3481.6	2744.4
36	4406.4	3460.5
48	7833.6	6152.0

How to Estimate Weights

In order to estimate the weight of a steel bar or rod, some method of figuring the weight must be used. The weight of steel is very deceiving to the eye; so a mere guess at the weight is very apt to cause serious damage and endanger the lives of workmen.

For example, take a piece of steel that is 16″ square and 20′ long.

PROCEDURE

1. Look in the first column of Table XXXVII headed "Dia. of Round or Side of Square in Inches" to find the size to be estimated, which is 16.
2. Look across the table under the heading "Weight in Pounds per Foot" and you will find that one foot weighs 870.4 pounds.
3. Multiply the weight of one foot by the total number of feet.
   20 x 870.4 lbs. = 17,408 lbs.
4. As most of the safe loads are given in tons, it will be necessary to divide the total weight by 2000, the number of pounds in a short ton (see table XXXVI).
   17,408 ÷ 2000 = 8.7 the number of tons.
5. To be safe, estimate the weight as 9 tons.
   NOTE: Do not use long tons (2240 lbs.) when estimating weights.

How to Estimate the Weight of Steel Plates

PROCEDURE

1. Measure the thickness of a plate in inches and the surface sizes in feet.
2. Figure the area of the plate by multiplying the length by the width. The product will be the number of square feet in the plate.
3. Look in the column marked "Thickness in Inches" for the size (Table XXXVIII). The number in the column marked "Weight in Pounds per Square Foot" is the weight of a square foot of a steel plate of the thickness specified.
4. Multiply the weight in pounds of one square foot by the number of square feet in the plate, and the result will be the weight in pounds of the steel plate.
5. If the result is wanted in tons, divide by 2000.

Table XXXVIII

THICKNESS AND WEIGHTS OF STEEL PLATES

Thickness in Inches	Weight in Lbs. per Square Ft.	Thickness in Inches	Weight in Lbs. per Square Ft.
1/64	.638	33/64	21.05
1/32	1.28	17/32	21.7
3/64	1.91	35/64	22.3
1/16	2.55	9/16	22.95
5/64	3.19	37/64	23.6
3/32	3.83	19/32	24.25
7/64	4.46	39/64	24.87
1/8	5.10	5/8	25.5
9/64	5.74	41/64	26.18
5/32	6.38	21/32	26.8
11/64	7.02	43/64	27.4
3/16	7.65	11/16	28.05
13/64	8.30	45/64	28.7
7/32	8.93	23/32	29.35
15/64	9.58	47/64	30.0
1/4	10.20	3/4	30.6
17/64	10.85	49/64	31.26
9/32	11.50	25/32	31.9
19/64	12.12	51/64	32.5
5/16	12.75	13/16	33.2
21/64	13.40	53/64	33.8
11/32	14.03	27/32	34.4
23/64	14.68	55/64	35.1
3/8	15.30	7/8	35.7
25/64	15.95	57/64	36.4
13/32	16.60	29/32	37.0
27/64	17.22	59/64	37.6
7/16	17.85	15/16	38.25
29/64	18.5	61/64	38.9
15/32	19.14	31/32	39.6
31/64	19.79	63/64	40.2
1/2	20.4	1	40.8

EXAMPLE:

A square foot of sheet steel $\frac{3}{8}''$ thick weighs 15.3 lbs. If the sheet measures 4′ x 8′, there are 32 square feet in one sheet. There are 10 sheets in the pile to be estimated. How many tons does the pile weigh?

SOLUTION:

$$\frac{4 \times 8 \times 10 \times 15.3}{2000} = 2.448 = \text{the number of tons.}$$

Estimate the weight as $2\frac{1}{2}$ tons.

ASSIGNMENT

Estimating Weights

OBJECTIVE

To get some idea of weights that are to be lifted.

TOOLS AND MATERIALS

Various square and round pieces of steel of different sizes.

Paper and pencil.

PROCEDURE

1. Refer to the table of weights given in the information sheet.
2. Estimate the weights of various pieces of steel by measuring them.
3. Answer the following questions.

QUESTIONS

1. **Figure the weight of 100 pieces of steel rod $\frac{1}{2}''$ in diameter and 10′ long.**
2. **What is the weight of a piece of steel 8″ x 8″ x 20′?**
3. **What is the weight of a steel shafting 10″ in diameter and 21′ long?**

PART II

ADVANCED INSTRUCTION
FOR
SHIPYARD RIGGERS

[21]
HANDLING HEAVY OR SPECIAL PIECES OF EQUIPMENT

General Information

When a piece of special equipment, such as a gear case, condenser, rotor, stator, bending machine, boiler, boring mill, or other heavy piece of machinery is to be installed in a ship or sent to a shop, arrangements should be made with the department concerned for immediate installation on its own base. At other times, pieces of equipment that go into a ship or the shop have to be stored, and arrangements should be made for proper storage away from fire hazards and water damage. The ground and cribbing on which the piece is to be stored should be suitable and solid. The proper kind of cover, tarpaulin, or roof should be provided, and it should be stored in a place that is accessible to a crane of suitable capacity. Properly covered pendants and other lifting gear should be available and handy in order to place the piece of equipment in the ship or shop as the special situation may require. Any type of crane may be used, and any space may be utilized where it will be safe from fire, water, and damage from being struck by other objects.

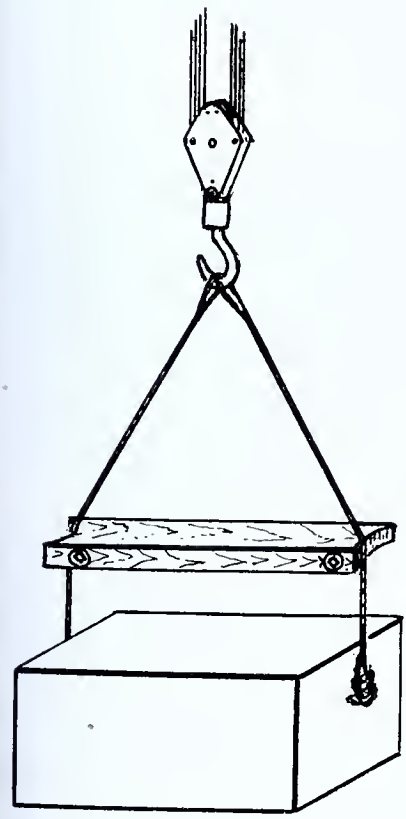


Fig. 175 — *A Spreader, used to protect the edges of equipment.*

Most jobs of installing special equipment call for the use of various rigging procedures. Care should be taken not to damage the equipment or the cranes. At times heavy pieces of equipment have to be rolled into place. All shaftings must be carefully protected with bagging or

chafing gear to prevent marring or breaking any part of the equipment.

Arrangements for the installation of any special pieces of equipment should be made with the electricians, machinists, pipefitters, or boilermakers in advance so that the foundations will be ready, and the proper cranes, chain hoists, blocks and falls, trucks, trailers, cars, and shifters are on hand and ready for use.

Occasionally these jobs have to be done with a pole equipped with chain hoists and tackles, especially if there is no crane available. Very often these jobs require the expenditure of extra hours for the rigger in order to allow the shop to use its own equipment without interruption. The question of policy dictated by the shop management determines whether specially arranged equipment must be used.

The unloading of cars should be completed as soon as possible after they have been properly placed, because a demurrage charge is made against the shipyard by the railroad company for each day the cars are kept loaded.

How to Install a Boiler

General Information

When the boiler has been built by the boilermakers and is ready for installation the riggers have all staging and planking removed that might interfere with or impede a quick and efficient placing of the boiler on the foundation in the boiler room of the ship. All brackets, hangers, piping, or other equipment that might interfere with the installation should be removed.

The boiler foundation must be in readiness; then, shackles, pendants, and, when necessary, chain hoists are arranged on the crane hook so that this lifting gear will not strain or damage the boiler or its tubes.

After the load is lifted off the ground, it is raised and lowered a few times to check the brake and crane for ability to handle the boiler's weight and to place it in position.

Occasionally a tag line is needed to keep the boiler from turning.

When everything is in readiness, the crane lifts the boiler and places it in the ship.

Boilers may weigh from 30 to 60 tons; because of this weight care must be exercised in the selection of the proper cranes and lifting gear.

TOOLS AND MATERIALS

2 pendants 36′ long, 1½″ dia., of improved plow-steel wire rope

4 1¾″ shackles

Lifting beams bolted or welded to boiler

Heaving line

Marline spike or wrench

NOTE: The lifting gear for handling a boiler may be altered to suit conditions, in which case pendants or chain hoists of special lengths will be required.

PROCEDURE

1. Check boiler foundation for readiness in the ship.
2. Have staging or other obstructions removed from boiler room.
3. Find out from boilermakers if boiler is ready.
4. Arrange for crane service.
5. Get out the lifting gear.
6. Hook up the lifting gear.
7. Have crane operator try the load.
8. Hoist the boiler into the ship.
9. Place boiler on its foundation.
10. Check the alignment.
11. Release the crane.
12. Remove the lifting gear.
13. Return lifting gear to rigging loft.

Installing a Turbo Electric Engine

Figure 179 shows the rigging gear necessary for hoisting a main engine stator of a turbo electric engine. Note that a ring is lashed to the top of the stator. Through the ring are wire rope pendants leading to the crane hook. A tag line is used to keep the stator from swinging and to move it into the correct position for lowering into the ship's engine room. While great care must be taken not to injure this piece of equipment, the procedure for installation is so much like that of handling other pieces of heavy or special equipment that exact procedures are not listed here.

FIG. 176 — *Rigging on and lifting a boiler from the point of construction.*

FIG. 177 — *Heaving a boiler over the deck.*

FIG. 178 — *Landing a boiler on its foundation. Notice the rigging.*

FIG. 179 — *A main engine stator of a turbo electric engine ready to be installed*

How to Install a Smokestack

General Information

The installation of a smokestack on a ship is a very important job, since it is usually one of the last major items of installation. Because it is very heavy, careful consideration must be given to the capacity of the crane which is to install it and to the height this crane will lift the stack. The ability of the various pier cranes and shipway cranes to lift smokestacks is dependent on the capacity of the cranes. Most smokestacks at the Sun Shipyard that weigh over 20 tons are installed by the riggers using the hammerhead crane. The pads, pendants, and shackles used by the riggers should be of proper size to lift and place the smokestack on the ship safely. The stack is installed on orders from the boilermakers, who have carefully checked with the riggers, machinists, pipefitters, and other departments so that any other installations required under the smokestack should be completed before it is installed. Particular care should be taken that the shipfitters, welders, burners, and riggers are on hand ahead of time and that they have their various tools, such as steamboat ratchets, drift pins, mauls, bolts, nuts, wedges, pinch bars, and torches available and ready for use. When a smokestack is installed on a ship, in the wet basin, it should usually be done at the low-tide period, or as nearly at that time as is practicable. This is necessary because all the possible lifting capacity of the crane is needed.

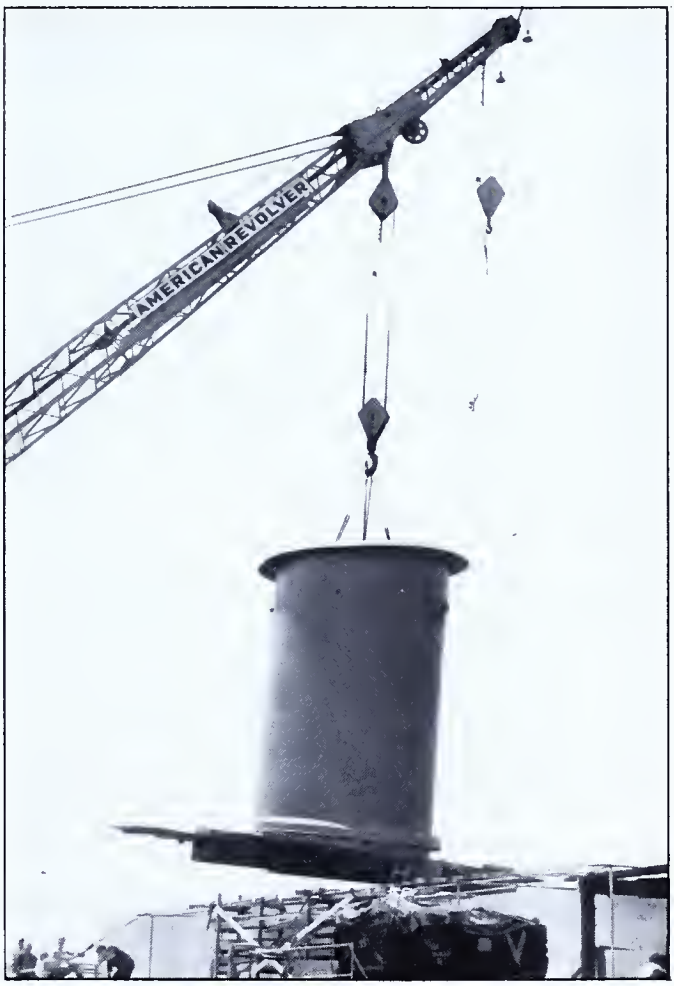


Fig. 180 — *Placing a smokestack on the deck.*

When the crane operator must lift the stack above the limit switch, an electrician is required to be in the control cab of the crane during this operation.

Sometimes extra shackles may be required on the forward or after lifting pads of the stack in order to make it fit the trim of the ship. Occasionally, equalizing bars or lifting beams may be used to install a smokestack, but generally on any job where two cranes are required to install a stack, the stack itself can be used as an equalizing bar or lifting beam. At the actual installation of the stack, the fitters, riggers, and boilermakers will cooperate to complete the installation promptly. Sometimes smokestacks may be installed successfully in as short a period as 10 or 15 minutes; at other times it has been known to take as long as 5 or 6 hours. The difference in time is usually directly proportionate to the amount of advance checking and arrangements that have been made by the shipfitters, boilermakers, and riggers.

Tools and Equipment

2 36′ 1¼″ dia. improved plow steel wire rope pendants.
4 1½″ screw pin shackles.
A crane of suitable lifting capacity
A 75′ tag line.

Procedure

1. Check with boilermakers to see whether or not the smokestack is completed, and double-check the welding on the lifting pads.
2. Check with shipfitters to see whether or not the boiler casing is ready for the stack.
3. Check with machinists, sheet-metal workers, pipefitters, and boilermakers to see whether or not there are any pieces of equipment to be installed under the stack base.
4. Arrange with stage builders to remove any staging or rails that may interfere with or delay the stack installation.
5. Arrange with shipfitters and boilermakers to install the stack at the time of low tide. (This is required only when the installation is made in a ship in a wet basin.)
6. Arrange lifting gear on the smokestack.
7. Have the crane operator raise the stack.
8. Have crane operator try the brake.

9. Place the stack on the ship.
10. Release the crane.
11. Remove the lifting gear.
12. Return tools and equipment to rigging loft.

Gin-Pole Rigging

General Information

When machinery or electrical equipment must be moved into a ship where there is no pier crane, ship's boom, or derrick available, the equipment must be handled by the riggers, using a portable pole, guys, tackle blocks, pendants, and chain hoist.

Poles will range in lifting capacity from 2 or 3 tons to 40 or 50 tons, depending on the equipment to be handled and the available lay-out for handling. The heavier the load, the more care and consideration must be given to supporting, bracing, and guying the boom. Sometimes air, steam, or electric power may be applied to lift the loads; at other times chain hoists may be used. The radius for safe handling is dependent on the diameter, manner of stepping, and length of the boom or pole.

Most pole work performed by the Sun Shipyard riggers is done on outside work where no cranes or other facilities are available.

Particular care must be taken that the boom is stepped and secured so that the heel will not kick out from under the load when it is lifted. Where heavier loads are to be lifted, doublers may have to be installed on the deck.

The equipment used for pole work at the Sun Shipyard consists of:

One 8″ x 8″ wood pole 23′ long.

Five or six 8″ double wood shell Manila rope tackle blocks.

A fitting band at the head of the boom.

Shackles and a hoist which will be either a chain hoist or a 10″ double sheave, steel shell wire rope block with wire rope for it, and a snatch block to lead to a deck winch, capstan, or anchor windlass.

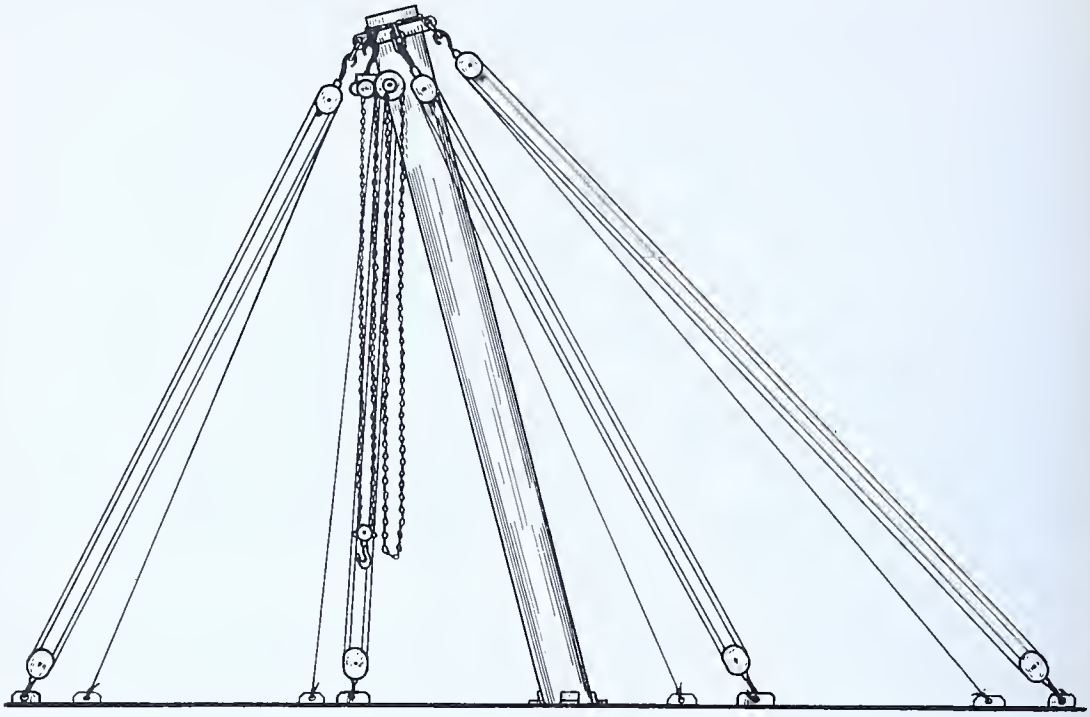


FIG. 181 — *A gin pole.*

QUESTIONS

1. Why are spreaders used on some pieces of equipment?
2. Why should cars be unloaded as soon as possible?
3. List the items to be checked before the riggers can install a boiler.
4. How much do boilers generally weigh?
5. Why is a tag line used when installing a piece of equipment?
6. Why should a smokestack for a ship in the wet basin be installed at low tide?
7. How can a smokestack be used as its own equalizing bar?
8. What departments are involved when a smokestack is being installed?
9. Why is it necessary for the crane operator to test the brake before hoisting a heavy load?
10. What is a gin pole?
11. When is it necessary to use a gin pole?

[22]
SPECIAL SHIP RIGGING

How to Install a Diesel Engine

General Information

The entire job of installing a diesel engine in a ship is in charge of a group of outside machinists who are especially trained for this job. All of the rigging work for the various engine parts is handled and put into place for the machinists by the riggers.

The procedures for installing or handling the various parts of a diesel engine are very similar; therefore only a few typical procedures are given.

Following are the main items of equipment that must be placed in the ship:

1. Bed plate and bearings
2. Crankshaft
3. Housings
4. Slipper guides
5. Column bridges
6. Pistons and top cages
7. Engine scavenger
8. Rods

There are so many different ways of handling this equipment that only general procedures can be specified.

How to Install Bed Plates

General Information

When the hull department has completed the engine-room tanks, when the machinists have lined up the tanks and made ready for the installation of engines, and when the shipfitters have provided all the necessary beam supports in the areas where heavy engine parts will be hung; the rigging gear,

consisting of shackles, pendants, and chain hoists, is hung on the overhead beams. All staging that might interfere with the installation of the engine parts is removed and, piece by piece, the bed plates and other engine parts are installed. The engine parts which are located under decks are carried into place with the help of chain hoists and cranes. However, some parts of the engine may be placed directly in position with the crane. Each bedplate section will weight approximately 53,140 lbs.

Tools and Equipment

6 — chain hoists with safe working loads of 10 tons.

6 — 3″ screw-pin shackles or

6 — hex nut and bolt shackles

6 properly supported trolley beams or brackets for giving vertical support to the shackles and chain hoists

Bagging and wood softeners

Hardwood blocking

1 — 3″ x 12″ nickel-steel lashing ring

1 — 1¼″ dia. or 1⅜″ dia. wire rope pendant

A crane capable of lifting 30 tons

Procedure

1. Hang pendants and chain hoists in the engine room for handling bed plates and bearings.
2. Have stage builders remove staging as required.
3. Have crane lift and carry bed plate into ship.
4. Land bed plate on tank top.
5. Remove chain hoists and pendants. After lining up and chocking has been completed by the machinists, which takes from 10 days to 2 weeks, the riggers proceed with the installation of other parts of the diesel engine.

Pendants and chain hoists for installation of crank shafting are again hung in the ship's engine room. By this time the ship's crane has been installed and can be used to advantage whenever necessary. The ship's crane is usually of 8- or 10-ton capacity and will facilitate the handling of many of the smaller parts of the engine.

How to Sling a Crankshaft

General Information

Diesel crankshafts are placed in the ship in sections because of their length and weight. Some of the sections can be lowered directly into place with the crane while others, because of the shape of the engine room, must be transferred to chain hoists, moved along to their proper places, and then lowered into position. One section of crankshaft will weight 49,650 lbs.

Tools and Materials

6 — chain hoists with safe working loads of 20 tons.

6 — 3″ screw-pin shackles or

6 hex nut and bolt shackles

6 properly supported trolley beams or brackets for giving vertical support to the shackles and chain hoists

Bagging and wood softeners

Hardwood blocking

1 — 3″ x 12″ nickel-steel lashing ring.

1 — $1\frac{1}{4}$″ dia. or $1\frac{3}{8}$″ dia. wire rope pendant

A crane capable of lifting 30 tons

Procedure

1. Hang a sufficient number of chain hoists in the ship to handle the crank shaft or the section that is being lowered. The chain hoists may be shackled into brackets inside the ship, or hooked into or slung over trolley beams if they are suitable for lifting the load.
2. Place sufficient bagging around the pin to protect it. Also, when necessary place wood softeners around the pin and brace the different webs with wood blocking for protection.
3. Lash a heavy ring to the pin with pendants.
4. Hook to the crane and sling the section into place, or where the section can be transferred to the chain hoists.
5. Move the section along by changing to various pairs of chain hoists until it is directly over its correct position.
6. Lower the section into place.
7. Proceed with the next section.

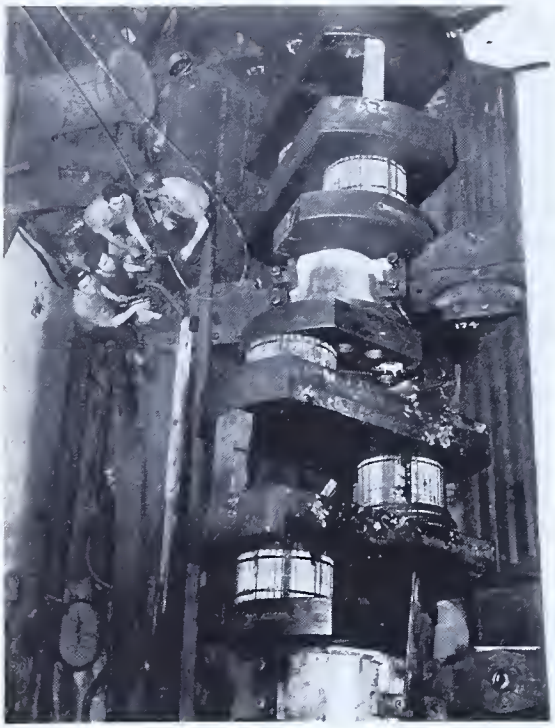


FIG. 182 — *Crankshaft resting in bearings.*

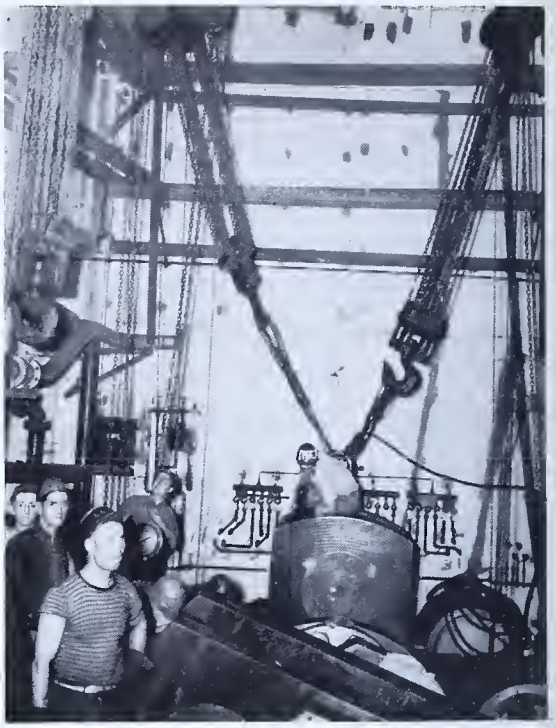


FIG. 183 — *Forward section of diesel engine crankshaft, with chain hoists attached, after being landed.*

FIG. 184 — *A column bridge section of a diesel engine being lifted into the ship.*

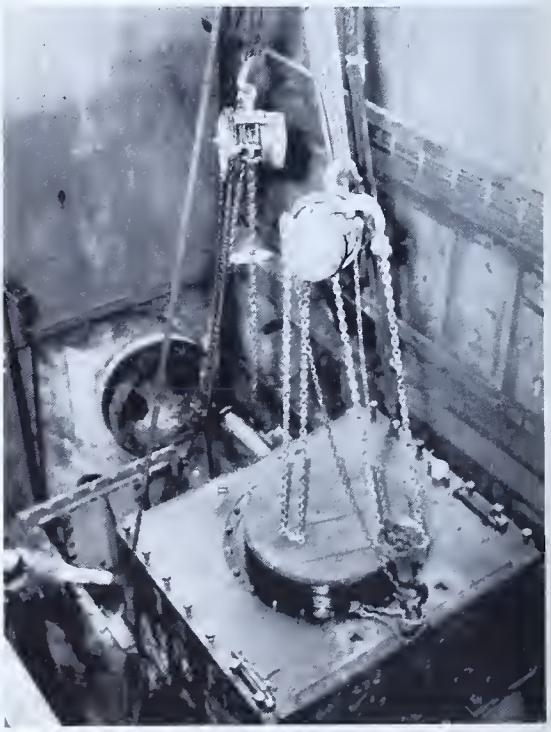


FIG. 185 — *A column bridge section of a diesel engine being landed in the ship's engine room. Note the chain hoists and other rigging.*

How to Install a Tail Shaft

General Information

When a tail shaft is being installed, there should be a suitable number of chain hoists hung in the ship ready to hook onto the tail shaft after it has been lowered by the crane.

Two rings are lashed to the tail shaft, one on the flange end and the other at the end of the brass liner, with a backer run from one ring to the other to keep them from slipping. The flanged or coupling end is raised by the crane hooked onto a wire rope pendant which is passed through the ring at that end.

The tail shaft is then lowered until the chain hoists can be hooked onto it. It is then carried into place by changing from one chain hoist to another.

The number of chain hoists used is generally four, but might vary according to the distance the tail shaft must be carried. Tail shafts generally weigh from 7 to 15 tons.

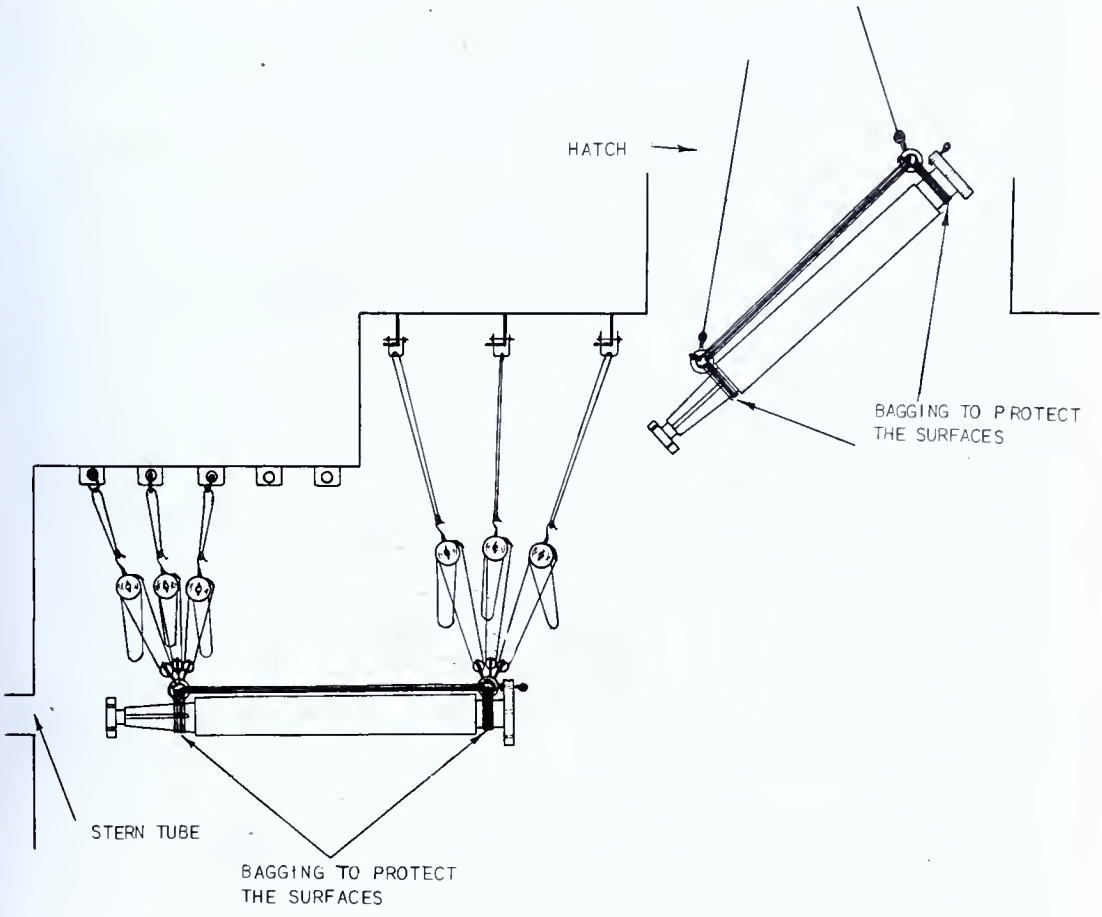


Fig. 186 — *Installing a Tail Shaft.*

Tools and Equipment

5 — 5-ton chain hoists — sometimes a 10-ton chain hoist is used under the boiler flat

1 — 20-ton crane

2 — Lashing rings, 2½" x 10", safe load 15 tons

Two pieces lashing, ¾" dia., 60' long

1¼" dia. wire rope pendants

Backer lashing with 1½" eyebolt and washers

Bagging

Procedure

1. Hang a suitable number of chain hoists in the ship ready to hook onto the tail shaft after it has been lowered by the crane.
2. Lash two rings, one to the flange end and the other to the end of the brass lines of the tail shaft.
3. Run a backer from one ring to the other to keep them from slipping.
4. Raise the flanged or coupling end with the crane hooked onto a wire rope pendant which is passed through the ring at that end.
5. Lower the tail shaft until the chain hoists can be hooked onto it.
6. Carry the tail shaft into place in the stern tube by shifting from one chain hoist to another as shown in Fig. 186.

Four chain hoists are generally used, but the number will vary according to the distance the tail shaft must be carried.

Occasionally a tail shaft may have to be placed on a shaft dolly and rolled into position.

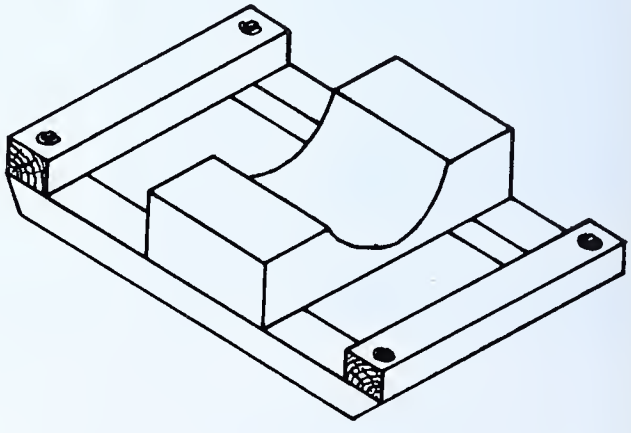


Fig. 187 — *Shaft Dolly.*

How to Install a Propeller

General Information

When a propeller is delivered to the shipyard as a rough casting, it must be weighed at once so that the manufacturer may be paid, and the shipyard may profit from any discount for prompt payment. The propeller is delivered to the hammerhead crane, where it is lifted onto a flat car whose weight is already known, taken to the scale house, weighed, returned to the storage space by the shifter and unloaded and stored until the Machine Department is ready to begin work on pitching, balancing, and machining it.

When the service propeller of a ship has been balanced and pitched and is ready for installation on the ship, and when the stern tube and tail shaft are ready to receive the propeller, it is brought to the shipway or dry dock where the installation is to be made. Propellers generally weigh from 16 to 22 tons.

Tools and Materials

$2\frac{1}{2}$" screw-pin shackles for each eye pad
2 — 20-ton chain hoists
Pendants
Cranes to lift 16-22 tons
1 — 3" x 12" nickel-steel lashing ring
Bagging
Backer — 60' of $\frac{3}{4}$" or $\frac{7}{8}$" dia. wire rope
Blocking
Lashing — 125' of $\frac{3}{4}$" or $\frac{7}{8}$" dia. wire rope

Procedure

1. Remove any staging that may interfere with the propeller installation.
2. Lash the ring to the propeller (see Figs. 188 and 189) in such a position that the keyway of the propeller will be up when lifted. Care must also be taken that the propeller lashing ring is in the athwartship position.
3. To keep the propeller from turning, lash a backer to it at such an angle that the propeller may be installed without additional work to get it into the correct position or angle. To get this angle, either use two crane hoists (or the heavy and auxiliary hoists of one crane), or land the bottom ends

of the propeller blades on blocking so that the position of the ring on the lashing can be shifted until the proper angle is reached.

4. Lift the propeller to the proper angle with a crane and carry it aft.
5. Hang heavy chain hoists to eye pads on the skin of the ship. Examine pads to see that they are fully welded and safe.
6. Shift the propeller into the aperture by using the heavy chain hoists. Care must be exercised to see that the weight of the propeller while being shifted into position is carried either by at least the crane and one chain hoist, or by both chain hoists.
7. Before swinging the propeller into place, run out the tail shaft, clean the fit, install the key, and examine and clean the propeller-nut threads. Haul the shaft back in flush with the outboard end of the stern tube. Keep the key in the tail shaft up, swing the propeller into position, run out the tail shaft carefully, and line up the key in the keyway. Install the propeller-shaft nut; and drive the wedges up, to the satisfaction of the machinists and the representatives of the ship's owners.

Figure 188 shows a typical propeller lashing and handling ring. Notice that the ring is secured in the athwartship position by 7/8″ or 1″ diameter wire rope with about 8 or 9 turns about the hub shoulder, which is protected at the blades by softeners of heavy canvas, rubber hose cut in half, or copper plates shaped into a U.

The lashing ring itself is made of nickel steel forged into a ring measuring 10″ to 12″ in inside diameter and 3″ in thickness.

In the picture you will notice that the turns going one way are on top and that the turns going the other way are on the bottom. This procedure is to make sure that the propeller weight is evenly distributed on the several turns of wire rope. (Note: — Most propellers now weigh from 16 to 22 tons.)

In addition to the ring lashing there is also a backer lashing so secured with two or three parts of wire rope as to hold the propeller in a nearly perpendicular position. This backer lashing keeps the propeller from turning when the center of balance is not in the center of the hub. This condition exists when the several (usually four) blades are pitched aft of the hub. Figure 189 shows a propeller being lowered into position from the crane to a chain hoist secured in pads in the stern shell above the wheel aperture.

FIG. 188

FIG. 189

How to Sling a Rudder

General Information

Most rudders have a hole through them which is used for making fast the rudder pads, of which there are two, one for each side. Each pad has two shackles, one at the top and one at the bottom.

Tools and Equipment

2 lifting pads with shackles at top and bottom of each

3 wire rope pendants, 1¼" dia.

1 turnbuckle

2 to 4 16-ton chain hoists

5-ton chain hoist

1 — 2½" screw-pin shackle for each chain hoist

Crane — 15- or 20-ton

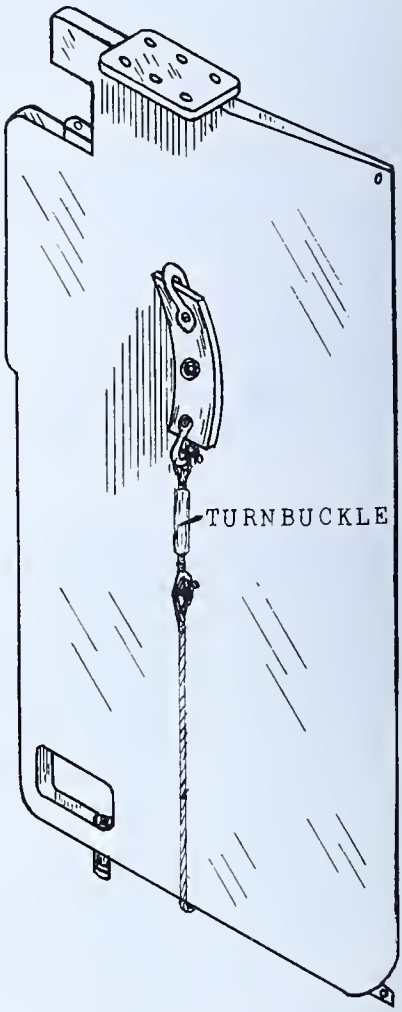


Fig. 190 — *A Rudder with Lifting Pad Installed.*

Procedure

1. After staging has been removed, block up the rudder in a position so that the pads may be fastened on each side.
2. Fasten the two lifting pads, one on each side, to the rudder by putting a bolt through the lifting pads and the rudder.
3. Fasten a turnbuckle and a pendant to the lower shackle of one lifting pad, and take the other end of the pendant around the bottom of the rudder and fasten it to the lower shackle on the other side.
4. Lash the two chain hoists to eye pads on the skin of the ship above the position of the rudder (one on each side).
5. The rudder is carried aft by a crane hooked to a shackle in the hole in the upper aft part of the rudder.

6. Pass pendants through each of the top shackles on the rudder pads and hook to the chain hoists.

7. Raise the rudder about one foot above its regular position.

8. Lower the pintle bolts into position; at the same time lower the rudder into position. As soon as the rudder is in place, the rest of the installation is done by the machinists.

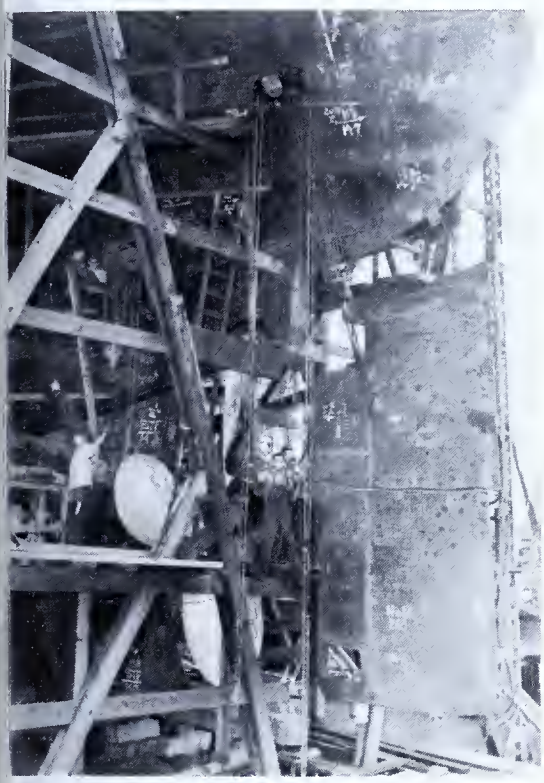


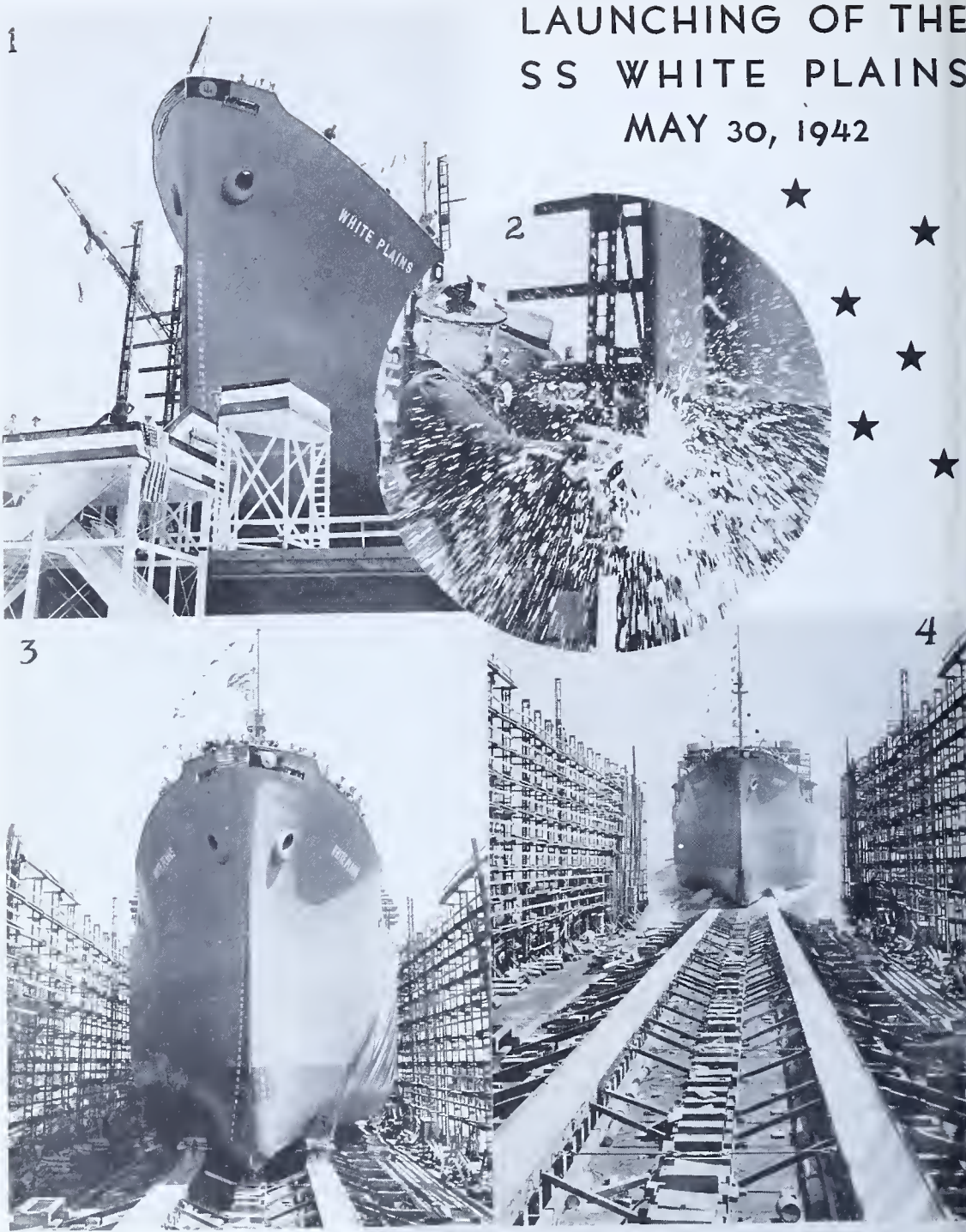
FIG. 191 — *Installing a Rudder.*

FIG. 192 — *Lining up Rudder Pintle Bolts and Gudgeons.*

QUESTIONS

1. Which section or sections of a crankshaft can be lowered directly into position by the crane?
2. Why is it necessary to weigh a propeller?
3. What tools and equipment are necessary when installing a propeller?
4. What is the correct position of the propeller lashing ring when installing a propeller?
5. What is the size of the lashing ring used when installing a propeller?
6. What is the purpose of the backer lashing on a propeller that is being installed?
7. What are rudder pads and why are they used?
8. What are pintle bolts?
9. To what are the chain hoists fastened when riggers are installing a rudder?

LAUNCHING OF THE SS WHITE PLAINS MAY 30, 1942



1 — Ready for launching.

2 — The christening.

3 — Starting down the ways.

4 — Another ship hits the water.

5 — The tugs take charge.

[23]
LAUNCHING A SHIP

General Information

Launching a ship requires a combination of labor and equipment, part of which involves the riggers. The information given here is not intended to tell how to launch a ship, but rather to give the general information that a rigger should know, and to list procedures for the various operations performed by riggers in launching a ship.

The riggers' work involves the following:

1. Lashing down the ground ways.
2. Securing toggle lashings tight and properly, that is, athwartship, up against the bottom shell of the ship.
3. Securing and making fast the toggle holding-up wires.
4. Packing wires.
5. Providing hauling-out wires for hauling out the sliding ways when the ship is afloat.
6. Securing the cradle wires which hold up the sliding ways aft.
7. Laying the river line or snubbing wire.
8. Securing the rudder.

All wires, clamps, shackles, turnbuckles, rings, and ropes used in launching a ship should be inspected. In placing all these wires and fittings, particularly toggle lashings, it is important to make them very tight.

The rudder should be secured with shackles, pendants, and turnbuckles so that it cannot swing.

The ship should be carefully examined, and any loose gear should be removed, secured, or lashed in place.

The navigating bridge should be clear of all obstructions that might interfere with the free movement of the Captain or the Dock Master.

The spaces adjacent to the mooring bitts and blocks should be cleared of all obstructions that might interfere with securing the tugboat and mooring lines.

A spring line of Manila or wire rope is placed on deck for checking and mooring the ship when it comes to its berth at the pier.

Two black balls, two feet in diameter, are hoisted on a mast above the superstructure of the ship to indicate that the ship, being out of control, cannot maneuver in the required manner, and that therefore all other ships must keep clear. The balls are hung in a vertical line, one over the other, not less than six feet apart, and where they can best be seen.

If the ship is to be launched late at night or during a period of darkness, two red lights shall be hoisted in a vertical line, one over the other, not less than six feet apart, and of such character as to be visible at a distance of at least two miles in any direction.

These red lights shall be hung on or in front of the foremast, or if the vessel is without a foremast, then in the fore part of the ship at a height not less than twenty feet above the hull, and if the breadth of the vessel exceeds twenty feet, then at a height not less than such breadth above the hull, but not to exceed forty feet.

An ensign should be flown on the stern flagstaff and a shield of stars and stripes should be displayed on the bow.

On special occasions a full set of code flags may be flown from temporary or permanent masts rigged up on the ship.

After the river line or snubbing wire is laid, a boat is dispatched to any floating craft, digger, or derrick that may be in the vicinity of the launching area. The operating crew will be notified to have their apparatus removed to a point where there will be no danger of collision with the launching hull or tugboats.

Any buoy that is in the way of a launching hull will be moved to a more favorable position by the buoy-tender boat or tugboats and replaced after the launching.

The ship is launched at the high-water slack interval when the flooding and ebbing motion of the water is the least effective.

All river traffic must be stopped at least fifteen minutes before launching time. A half-hour is recommended.

As soon as possible after the launching, all packing, packing wires, toggle wires, sliding way, and river wires and chains should be removed from the ship or hauled in from the river bottom.

The wood packing and launching cradle should be returned to the carpenters and shipfitters at the shipway where the next ship is to be launched.

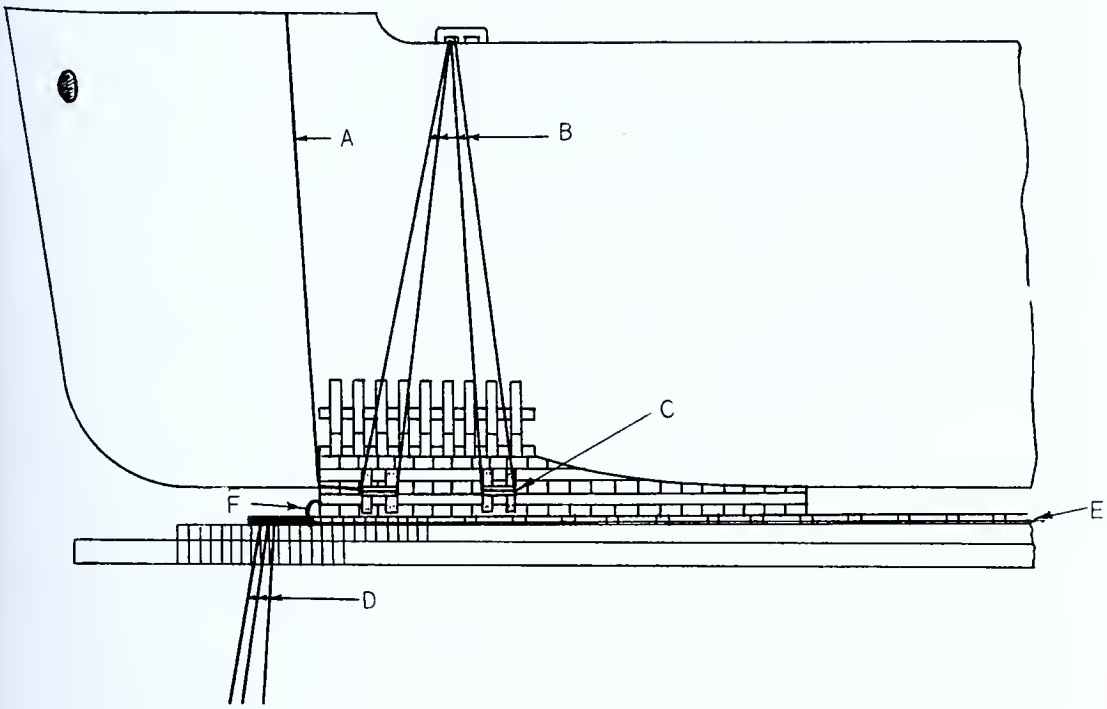


Fig. 193 — *Showing Various Wires at the Port Bow.*

A — Packing Wire.

B — Toggle Wires Up and Down.

C — Athwartship Toggle Lashing.

D — Holding-down Wires for Ground Ways.

E — Bight of the Sliding Way Hauling-out Wire.

F — Where the Sliding Way Hauling-out Wire is Fastened.

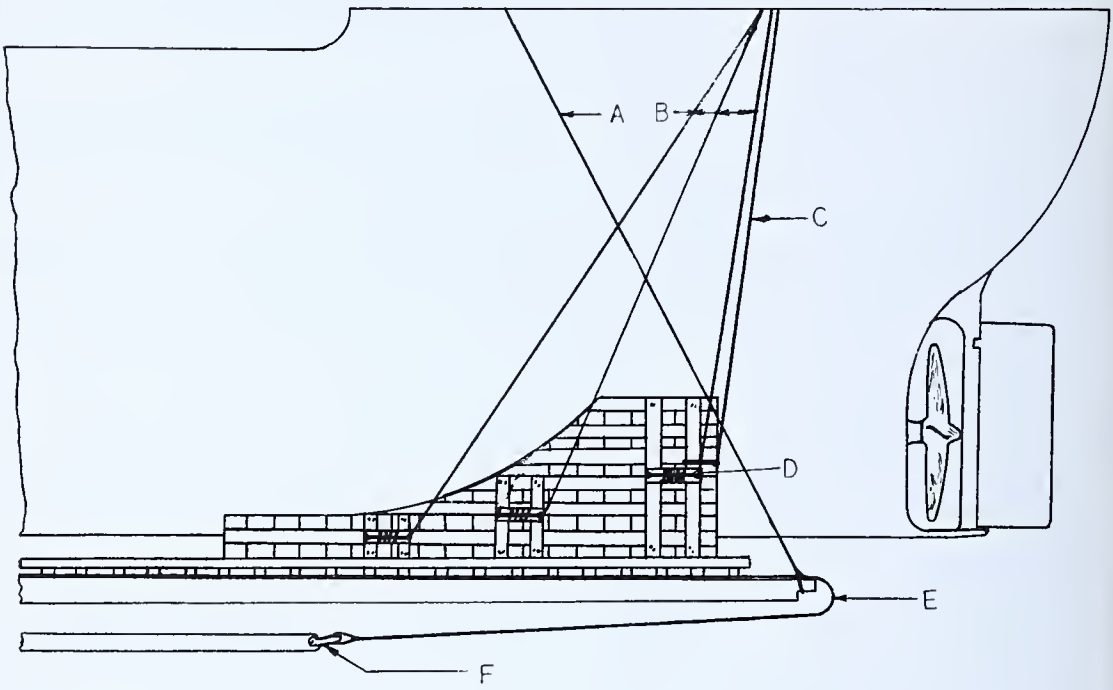


FIG. 194 — *The Various Wires at the Port Quarter or Stern View.*

A — Holding-up or Cradle Wire for Sliding Ways.

B — Toggle Wires Up and Down.

C — Stern Packing Wire.

D — Athwartship Toggle Lashing.

E — Bight of the Sliding Way Hauling-out Wire.

F — Anchor or Secured End of Launch Way Pulling-out Wire.

How to Lash Down the Ground Ways

GENERAL INFORMATION

Lashing down of ground ways under the bow of the ship is necessary because the shifting of weight, as the ship slides down, tends to lift them. The number of holding-down wires will vary according to the size of the ship, its position on the shipways, and whether or not it is a standard length of ship. In some yards the ships are all of the same size and length and require a fixed set of gear. At other yards the holding-down wires vary in length and a more variable set of gear is required. Also, the holes under the concrete supports may have to be dug out and reinforced.

The location of the holding-down wires is established by the carpenters, who use a plumb line hung from the ways.

The holding-down wires or rods have to be drawn very tight in order to be of value.

Tools and Equipment

$2\frac{1}{2}$" or 3" rods, 6' or 8' long or wire rope lashings.

Heavy $2\frac{1}{2}$" or 3" bottle turnbuckles.

$2\frac{1}{2}$" shackles.

A heavy U strongback.

A 48" Stillson wrench.

Procedure

1. Prepare the holes through which the holding-down wires or rods are to pass.
2. Set the strongback across the top of the ground ways at a point over their location under the ship's bow.
3. Drop the rods down the holes on each side. Where wire rope lashing must be used it will have to be passed up and down and around until sufficient turns are made.
4. Shackle the rods to the strongback.
5. Open up and connect the turnbuckles from the bottom of the rods to the shackles secured in the shipway shoring.
6. Make the turnbuckle taut. Repeat this procedure at each point where the ground ways must be held down.

How to Secure Toggle Lashings

General Information

When the carpenters have completed the wood blocking under the launch brackets or ship and have installed the uprights on the outboard sides of this packing, the riggers may begin to pass the toggle lashings back and forth from side to side until each toggle is held in place by 9 turns. As each turn of this wire is made it is heaved tight with a 4- or 5-ton chain hoist, then clamped tight until the next turn is passed and ready for heaving tight.

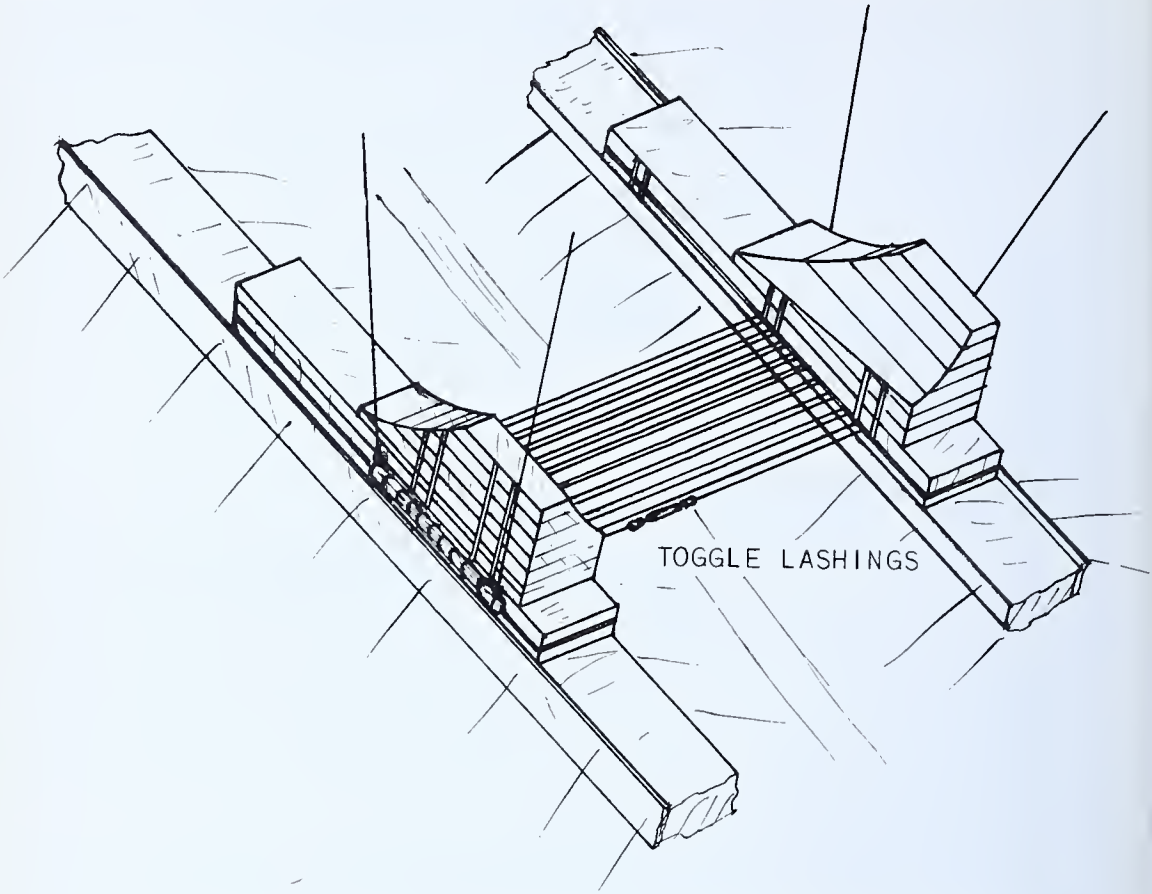


FIG. 195 — *Toggle Lashings Made Fast under Bow of Ship.*

TOOLS AND EQUIPMENT

A 4-ton chain hoist
Shoring or crane-tower braces
Chain stoppers
Wire rope clamps
Socket wrench
A 10-lb. maul
Marline spike or spud wrench
200′ - 250′ length of 7/8″ or 1″ dia. wire rope of a flexible composition
2 pipe toggles for each lashing

PROCEDURE

1. Place toggles on wood packing.
2. Secure chain hoist to stage tower framing or other heavy member.

3. Pass the toggle wire athwartship around the toggles and back to one side.
4. Haul the wire tight with the chain hoist and the wire rope chain stopper.
5. Secure the wire with a wire rope clamp.
6. Pass another turn around the toggles and back.
7. Haul this tight.
8. Reclamp the new turn.
9. Repeat this procedure until from 7 to 9 turns are made about the toggles.

This entire procedure must be repeated for all toggle lashings, of which there may be from 5 to 9, depending on the size of the ship and the fineness of its lines at the bow and stern.

How to Secure and Make Fast the Toggle Holding-up Wires

General Information

The toggle holding-up wires are secured by means of shackles in the ends of the pipe toggles and then led to the deck above in the manner shown in Figs. 193 and 194. These wires are sometimes referred to as the up- and-down wires, both at the bow and the stern. Generally the toggle holding-up wires or up-and-down wires are arranged to be slipped on the starboard side aft so that the toggle lashings and packing may be removed from the stern where all this launching gear will be submerged beneath the water. Generally the toggle holding-up wires can be removed from the bow with the aid of a crane hoist or pier winch messenger and winch without the necessity of slip toggles such as those described in the procedure.

Tools and Materials

For each toggle at each end of each lashing:

2 — 7/8" or 1" screw-pin shackles secured in the pipe toggles.

2 — 75 ft. lengths of 3/4" dia. flexible wire rope.

A mooring bitt and mooring chock for securing the ends on deck.

Rope yarns for holding the wire rope ends tight.

Procedure

1. Pass the wire down from on deck.
2. Secure it to the pipe toggles with a 7/8" or 1" shackle.

3. Haul it tight on deck.
4. Make it fast on deck.
5. Stop the ends off with new rope yarns.
6. Repeat this procedure for each toggle holding-up wire.

Packing Wires

The packing wires retain the packing to the ship so it can be used again when launching other ships. Generally there is one packing wire on each side of the ship at the bow, and two on each side at the stern. These wires are made fast on deck and to the packing on both sides at the bow and the stern. See A on Fig. 193 and C on Fig. 194.

How to Secure the Sliding Way Hauling-out Wires

General Information

The purpose of the sliding way hauling-out wires is to recover the sliding ways from under the ship as soon as it is water borne. They are secured under the bow to the sliding ways as shown at F in Fig. 193 (bow), and are shackled into a built-in fitting. They are tied up with rope yarns to the carpenters' wedges, led along the full length of the ship and secured near the stern to heavy steel or concrete piles on the shipways at the point F as shown in Fig. 194 (stern). At the point F, there may be either heavy wire pendants or heavy chains bedded under the concrete piles.

Tools and Materials

Two 1⅝", 6 x 24 galvanized mooring wires, 475' long
4 shackles
Rope yarns

Procedure

1. Lay out the wires under the bow of the ship at each side.
2. Secure the wires at the bow to the sliding ways.
3. Haul the wires aft along the sliding ways.
4. Tie the wires up with rope yarns to about every third ramming wedge.
5. Lay out the bights of these wires at the stern of the ship so they will be free from turns.
6. Secure stern ends of wires to the chain or wire rope pendant at the stern on the ways.

How to Secure the Cradle Wires

General Information

The holding-up or cradle wires hold the sliding ways up against the bottom shell of the ship and prevent the ways from grounding or fouling as the ship slides toward the water. They are hooked on deck and joined together underneath the ship between the sliding ways by shackles and a skeleton or open-type turnbuckle which is tightly secured. The wire is of $\frac{7}{8}$″ or 1″ diameter and is made to suit the needs of the ship.

Tools and Equipment

60′ to 70′ of $\frac{7}{8}$″ to 1″ dia. 6 x 24 galvanized mooring wire
2 shackles, $1\frac{1}{4}$″
1 skeleton turnbuckle, $1\frac{1}{4}$″ with about 24″ take-up
Mooring chocks and bitts on deck
24″ Stillson wrench or bar

Procedure

1. Lay out the turnbuckle and shackles under the ship's bottom between the sliding ways at the stern of the ship.
2. Pass the wires down from on deck on each side of the ship through the notched after ends of the sliding ways.
3. Join the bottom ends of these two wires to the turnbuckle with the shackles.
4. Heave the wires hand-tight on deck.
5. Secure to mooring bitts on deck.
6. Draw the wires tight with the turnbuckle.

How to Lay a River Line or Snubbing Wire

General Information

In order that a ship that is being launched may be held, a river line is laid before launching.

The river line should be laid at high tide, for two reasons: (1) the slack water lasts longer, and (2) when the tide is at its greatest height it keeps the barge or float from being ashore or aground and gives greater maneuverability close to the shore.

Tools and Equipment

700′ of 2″ wire rope
450′ of 1¾″ wire rope
400′ of 1⅝″ wire rope
90′ of 2¼″ anchor chain
3 detachable links
1 anchor swivel
Manila rope lashings
Wood blocking
Lifesaving belt for each man

Procedure

1. Load the wire ropes and anchor chain on the float so they will uncoil easily. It is very important that these wire ropes and chains be coiled in the proper manner, and that the riggers working on the barge know exactly what to do, and how to do it fast. When the line begins to go overboard it moves very rapidly. The barge is supplied with life belts in case a man is carried overboard.

Have the various parts of the river line or snubbing wire attached to each other in the following order:

700′ of 2″ dia. wire rope
A detachable link and an anchor-chain swivel
90′ of 2¼″ dia. anchor chain
A detachable link (sometimes called joining link)
450′ of 1¾″ dia. wire rope
A detachable link
400′ of 1⅝″ dia. wire rope

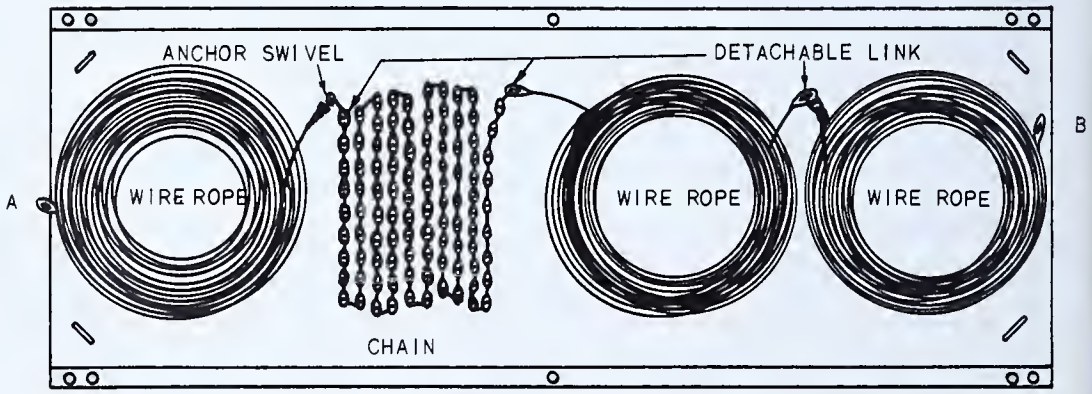


Fig. 196 — *Showing How the River or Snubbing Line is Arranged on the Float*

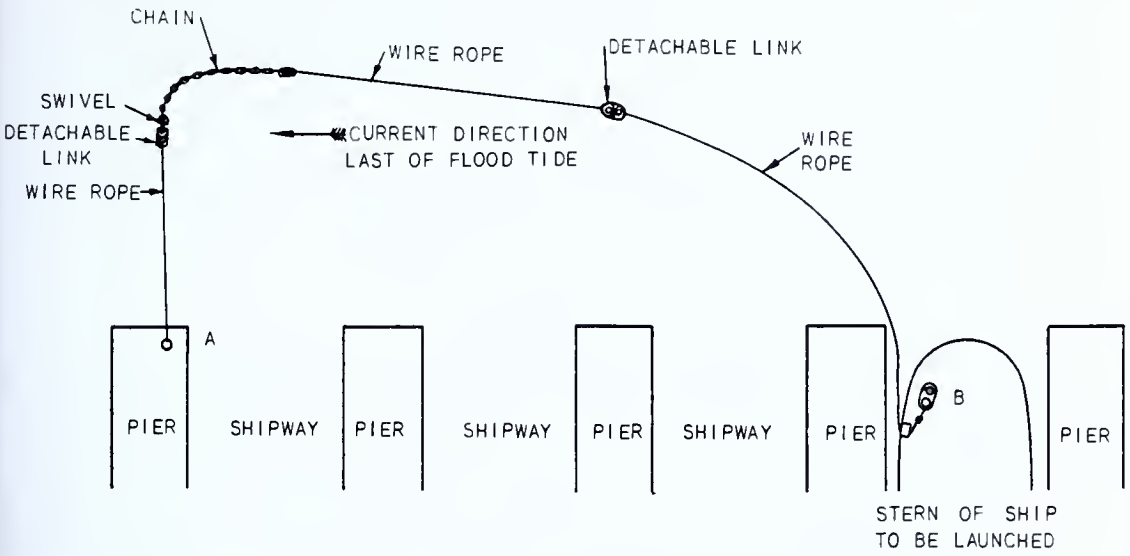


Fig. 197

2. Anchor the "A" end of the line to a chain secured to a concrete pillar, to the columns at the end of a shipway, to the end of the crane runways, or to a mooring post on the end of a pier.

3. Fasten the "B" end to the barge or float so that it cannot get away from the barge before it can be made fast to the ship.

4. Have the barge towed well out into the river or body of water by a power boat or tug, allowing the snubbing wire to uncoil as the barge is towed along. The men on the barge must work fast to keep the line from tangling and taking too much out at one time. They must also take care not to be carried overboard with the line. Each man wears a life belt.

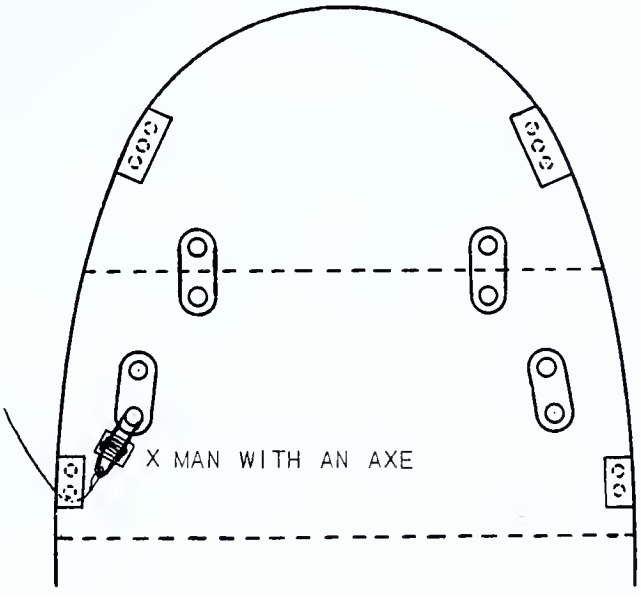


Fig. 198

5. When the course of the line is completed as shown in Fig. 197, unfasten the "B" end from

the barge, and make it fast to the stern end of the ship on deck with a Manila rope lashing as shown in Fig. 198. This Manila rope lashing is blocked up with wood to facilitate cutting when the launching is completed and the tugboats have control of the ship.

How to Secure a Rudder

General Information

The rudder of the ship must be secured for launching so that there will be no damage to steering gear, rudder stock, or rudder.

Tools and Materials

2 skeleton turnbuckles, 24″ x 1¼″.

2 pendants of 1″ dia. and of suitable length.

2 shackles for securing pendants to the rudder lifting pads.

1 close-fitting 1½″ shackle secured to the after top end of the rudder in a pad provided there.

Other small pendants as may be required to complete the connections between the rudder pad and the rudder lifting pads on the hull shell.

24″ or 36″ Stillson wrenches

Several 1½″ washers.

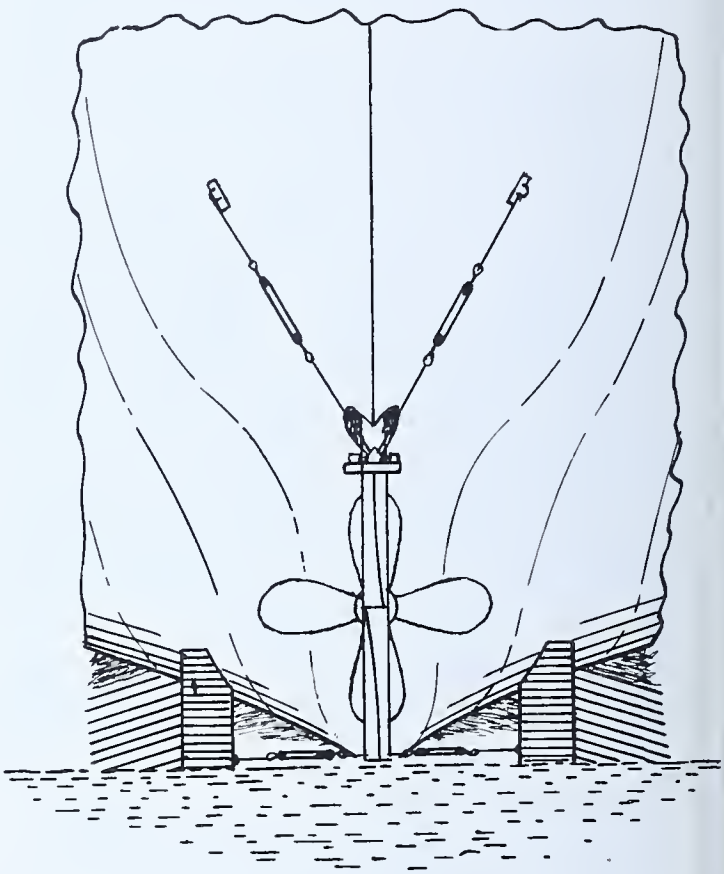


Fig. 199 — *Showing the Rudder Made Fast.*

Procedure

1. Hang pendants in shackles secured in the rudder lifting pads.
2. Hang turnbuckles in the pendants.
3. Install close-fitting shackle to the rudder pad on the top of the rudder.

4. Connect the turnbuckles or small pendants (if required) to the shackle on the rudder. The shackle may have to be filled with washers to eliminate lateral motion.

5. When all fittings are connected as shown in Fig. 199, draw the turnbuckles tight with a Stillson wrench.

QUESTIONS

1. **What are the riggers' duties in launching a ship?**
2. **What is the purpose of a snubbing wire?**
3. **Why is chain used for a section of a river line?**
4. **How is the rudder kept from turning when the ship is launched?**
5. **When and why are two red lights hoisted on a ship after it is launched?**
6. **What do two black balls hoisted on a ship indicate?**
7. **State the functions of the various wires used in launching a ship.**
8. **What is a strongback and why is it used?**
9. **What is a bottle turnbuckle and what advantage does it have over an open turnbuckle?**
10. **What is a chain stopper?**
11. **Why is a swivel used on a river line?**
12. **When a river line is made fast on deck, why is blocking placed under the lashing?**

[24]
MOORING A SHIP

General Information

Mooring a ship during the various stages of construction after launching calls for properly placing numerous mooring wires which range in size from ¾" to 1½" in diameter, depending on the length of the wire, its location, and the work that it has to do. It is important to everyone concerned that the ship should be securely moored during the time that it lies in the wet basins between launching and delivery.

Conventional Method of Mooring

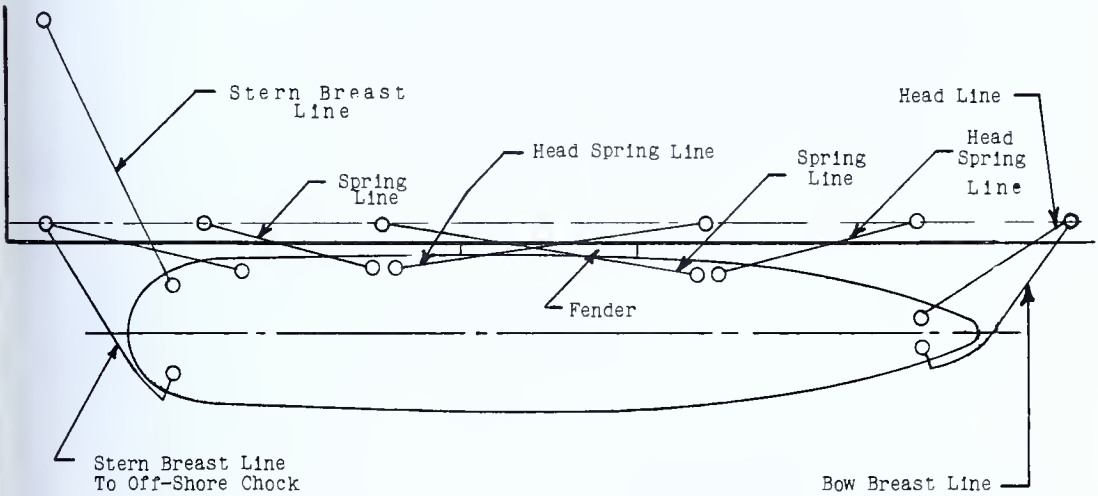


Fig. 200 — *The Conventional Method of Mooring a Ship.*

Spring lines are always used in tying up a ship at a dock, and these, in conjunction with breast lines and bow and stern lines, make up the regular mooring lines of ships alongside a dock.

Mooring With Bow Against Bulkhead

Fig. 200A shows typical mooring where the bow of the ship is kept tight against a heavy wood or rope fender backed up by a concrete bulkhead. This type of mooring requires the least number of mooring wires, gives the

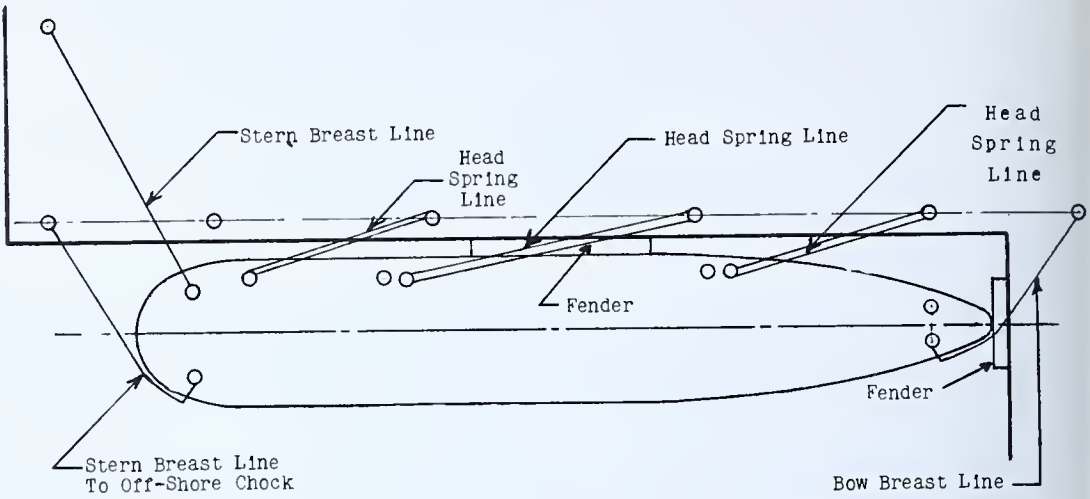


FIG. 200A — *Mooring with Bow against Bulkhead.*

greatest security to the ship, and maintains the ramp gangway in the safest position. In this typical mooring, a heavy, bow breast wire leading around the bow to the chock on the off-shore side at the break, or around the break of the forecastle head, will be sufficient for a forward breast. About three mooring wires, leading to two different posts, will be sufficient to take care of the stern. Additional mooring wires at the stern are needed because the ship's stern, being nearer the stream, is affected more by the tide.

Mooring Where Bow Cannot Rest Against Bulkhead

At some piers, mooring a vessel requires more wires and extra care be cause the bow of the ship cannot be placed against the bulkhead of a pier

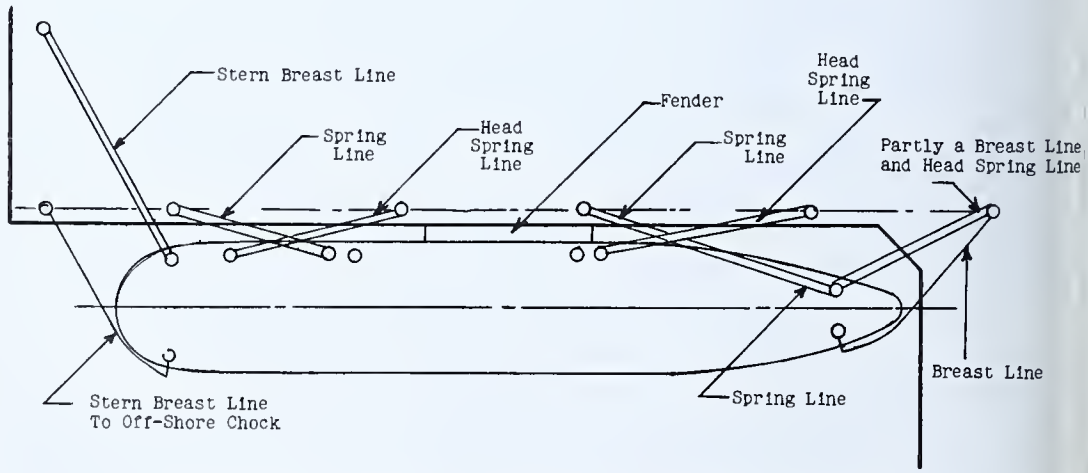


FIG. 200B — *Mooring without Bow against Bulkhead.*

which is not backed up by concrete. See Figure 200 B. Sometimes pier posts turn in their sockets, in which case the wires must be made fast on deck.

This type of mooring requires three additional mooring wires leading aft from the deck to the pier, to keep the bow from striking and damaging the forward bulkhead of the pier. The ship should be kept back five or eight feet with as long leads on the mooring wires as possible, considering their lengths.

Ramp gangways at these piers have to be watched and checked more frequently because the ship can move in and out to a greater extent.

Fig. 201 shows the leads for mooring lines.

When a lead for a mooring line passes from a chock to a fairlead to a windlass drum, the hauling part should line up with the inboard part of the drum.

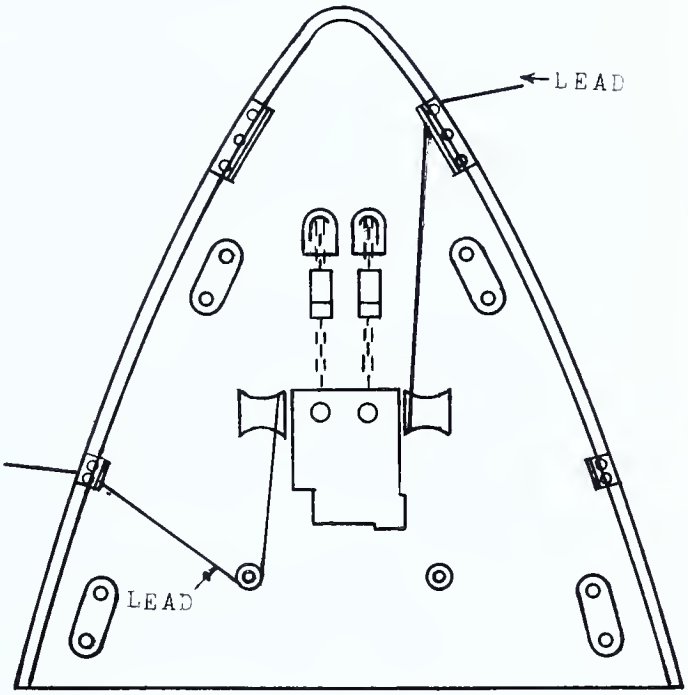


FIG. 201 — *The Leads for Mooring Lines.*

Fig. 202 shows the manner of securing a mooring wire to a pier post.

When being moved from berth to berth, ships are generally handled with combinations of tugs, engines, rudder, mooring winches and mooring lines on deck, and mooring winches and wires on the pier.

Various conditions of wind and tide will create problems in bringing the ship to her mooring berth.

Generally, the principal problem is getting hold of the ship quickly when it is in position. It is good

FIG. 202 — *Making Fast a Mooring Line.*

practice to get a single-part bow breast line and a single-part stern breast line out and secured. Then proceed with head lines, spring lines, and stern lines. When there are sufficient mooring lines on the ship to hold it, land the gangway and dismiss the tugs. Prompt dismissal of the tugs after the ship is made fast is very important because the use of tugs is very expensive.

When crowded conditions, narrow basins, a strong wind or tide prevent the tugs from holding a ship in position, the men on the pier will run out a hauling wire from a winch through a snatch, or snatch blocks, to the ship for the purpose of holding or pulling the ship into position for mooring. The need for this occurs often enough that this hauling wire should always be ready to send up to the ship when needed, just as tackles, straps, chains and stoppers are prepared in advance.

In moving and mooring ships, the snatch block for the hauling wire should be led to a post on the pier on the opposite side of the berth which the ship is to occupy.

Particular care should be taken to have the gangway ready to land on the ship so the men may be promptly put aboard or taken off. The platform should be properly fastened on deck before the crane is released.

To be secure, either on bitts on deck or on a mooring post on the pier, any wire or line should have at least five or six turns on the bitts or post and at least three stoppers of 18-thread Manila rope or a single strand of Manila rope.

The supervisors of the riggers' department must be notified of the time of arrival or departure of any ship. Arrangements should be made in advance for steering gear, main engine propulsion, or power on deck machinery when they are required or are available.

Likewise, when power is required on the pier winches or when mooring wires are required to haul ships, arrangements should be made in advance.

When the bow or stern of a ship extends into the river beyond the end of the pier, the electricians will be required to hang mooring lights over the sides at the bow or stern, whichever extends out into the stream.

Six-men gangs are generally required at each of the following points of mooring a ship:

1. The bow on deck.
2. The bow on pier.
3. The stern on deck.
4. The stern on pier.
5. One extra man to stand by the gangway, ready to land it or remove it.
6. A licensed officer to stand by on the bridge with the captain in charge of moving.

Particular care should be taken by the leaders of the men on deck to act promptly in making tugboats fast and letting go tugboat lines during the mooring of a ship. The leader should divide his gang so that they can handle tugboat lines on both sides of the ship when necessary. Heaving lines, tackles, straps and stoppers should be ready for use. The leader should watch the foreman on the dock and the dock captain on the bridge during the moving and docking of the ship, in order to execute promptly any orders given to him from either the dock or the bridge.

Leaders on deck should notify the tug captains at various intervals of the amount of clearance (in feet) between the ship and the dock.

The particular placement of a ship at any berth is in charge of the foreman on the pier. He signals to the captain on the bridge where and how the ship is to be moored, except in special cases when the docking captain on the bridge will have to place the ship in the berth as he has been instructed.

Moving a Ship From Berth to Berth

Following is the procedure for letting lines go when a ship is to be moved from one berth to another.

A letter is sent to all department heads and key employees announcing when the ship is to leave, from what point it is to leave, to what pier it is to go, whether it is to be moored bow in or stern in, and other particulars.

Arrangements for tugs to handle the vessel are made by the rigging department foreman or superintendent.

The welders, pipefitters, and electricians disconnect hose, lines, and wires. The riggers single up the ship and remove the gangway platform.

When the tugs are ready, the foreman on the dock, on signal from the bridge, gives the order to let go the last mooring lines. Quick work on the part of the men is required on these lines, because the tugs begin moving the ship immediately after the "let go" signal is given. On letting go ships that have been under repair, contact the crew of the ship an hour or two before the appointed time for sailing, check the deck, engine room, and other work areas for shipyard equipment, remove equipment to shore, and stand by to remove gangway and let go lines.

When a ship is moored at low tide, allowance should be made so that the mooring lines will not be too tight at high tide.

Heaving lines, stoppers, tackles, straps, and messenger wires should be ready on deck or on the pier as circumstances may require.

When the situation warrants, use bights of mooring line, being careful that the hauling part is on top or on the outside, and that there are no turns in the wire.

When the ship is ready for dock trial, additional wires should be placed on it, and those already on should be checked for tautness at high tide.

Moving a Ship by Winch Wires

To keep the ship under complete control it is most important that the hauling wires and slacking wires should be of the proper size and led so as to provide maximum control of the ship and minimum strain on the hauling gear.

When a ship is to be moved or hauled from berth to berth in the same basin, the work is done by means of pier winches, wires, and snatch blocks. See Figs. 203 and 203A.

The winches used in this procedure are those located at the end of the piers and at the heads of the basins. They are 20- to 30-horsepower, low-geared, and slow-hauling, which features are necessary for efficient ship

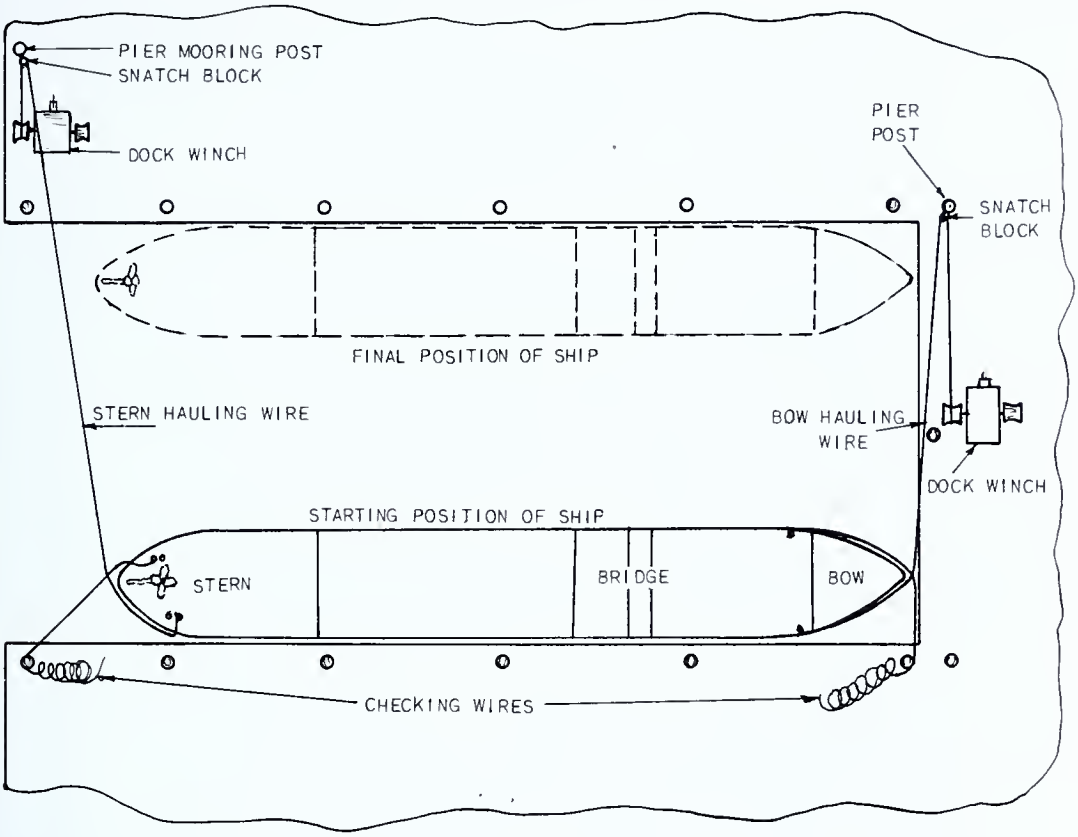


FIG. 203 — *Moving a Ship with Winch Wires — Bow in.*

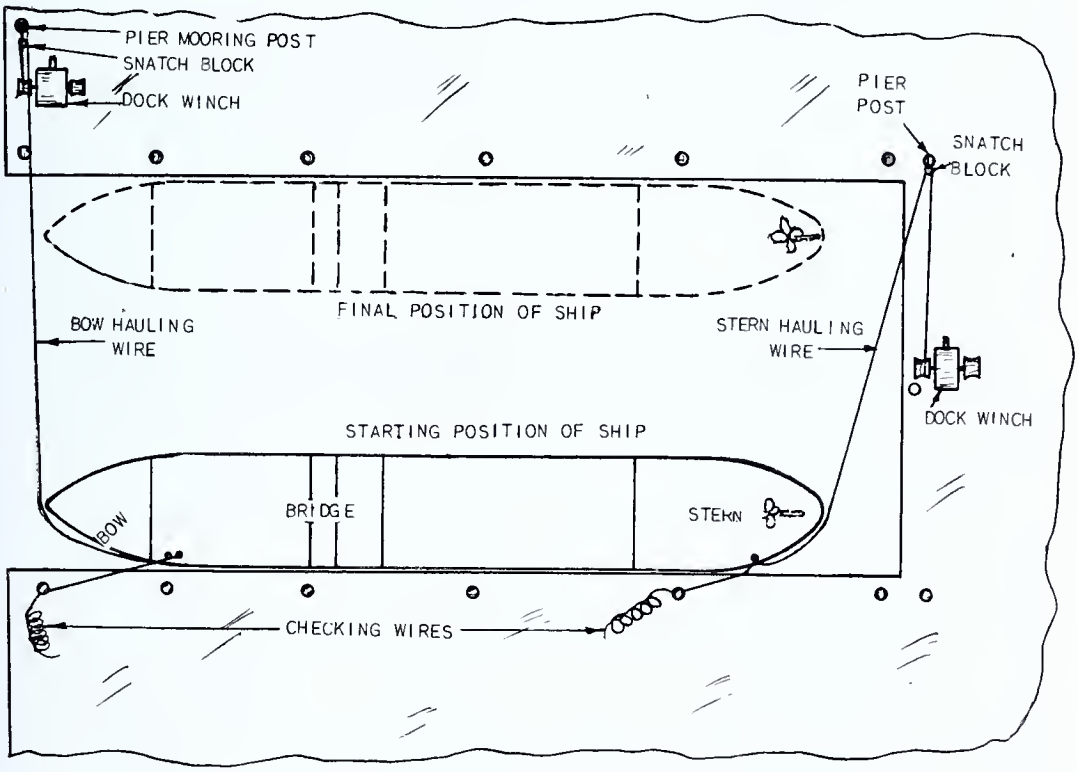


FIG. 203A — *Moving a Ship with Winch Wires — Stern in.*

handling. The hauling wires, 1″ to 1⅛″ in diameter spring-lay wire ropes, should lead to the ship around the bow and around the stern to the off-shore side, away from the pier to which the ship is to be hauled.

The lead of the slacking wires from the pier to the ship is not quite so important as the lead of hauling wires. The slacking wires are important, however, when a vessel is in a basin with the stern toward the bulkhead, in which case the wire ropes must be so arranged that the ship will not strike the bulkheads and cause damage to the hull, propeller, or rudder.

The ship should be hauled slowly and carefully to prevent any damage.

The proper use of a pier winch is an accomplishment that comes with practice and watchfulness. The application of power to pier winches must not be sudden or excessive because the hauling wire may easily be broken. If the winch motor is not turning, the power must be shut off.

Men working near blocks or wires must be kept out of the danger area, which is called the bight.

The forces of wind and tide must be taken into consideration. The best time for moving a ship is near the maximum flood stage. On the maximum ebb stage, a ship must not be hauled across the basin because a hump rises in the middle of the basin and causes the ship to be grounded, with incidental loss of time, damage to equipment, and possible damage to the hull.

Conducting Engine Dock Trial

PROCEDURE

1. Before starting engines, make sure the area around the propeller is clear of logs, ropes, and other obstructions afoul, or likely to foul, the propeller. Be sure the ship is properly moored, that her bow is against the rubbing fender at the forward bulkhead, and that a sufficient number of spring lines are on the ship to prevent the ship from breaking its mooring.
2. Discuss and arrange for signals with the engineer in charge of the dock trial so that engine room, telegraph, or some other means of signalling is agreed upon.
3. Be sure that anchors are ready for letting go. During the dock trials, keep a careful watch on all mooring lines and the ramp gangway. If either needs to be adjusted, notify your foreman.

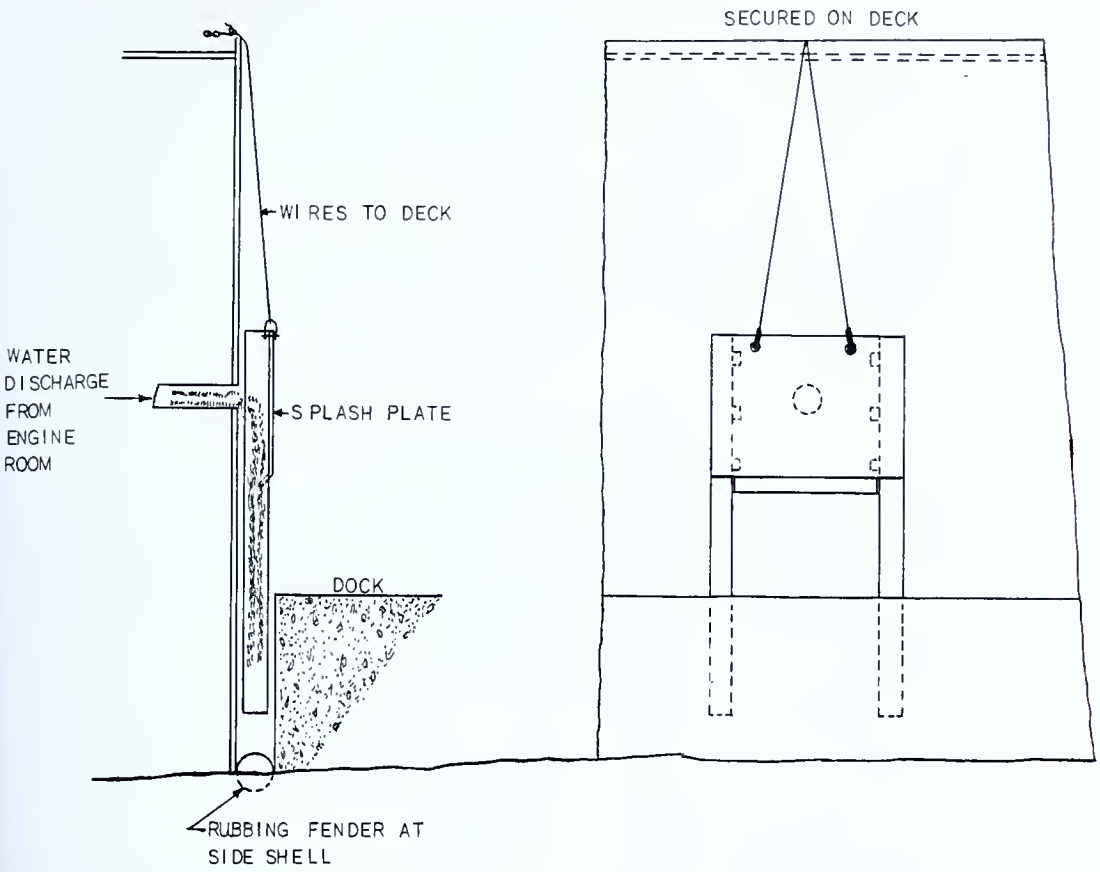


FIG. 204 — *A Specially Designed Splash Plate Hung on the Side of a Ship.*

4. Stop the ship's engines while handling mooring lines, any other lines about the stern, or lines to and from the piers. Use your discretion about stopping engines when the propeller wash is affecting a vessel being maneuvered in the same or adjoining basins. The propeller may be reversed at your discretion.

5. When the vessels are running dock trials and pumping water through the overboard discharge pipes, specially designed splash plates are used to keep the water from flooding the dock, damaging equipment and endangering men's lives by short circuiting electric wires. If splash plates are required to protect piers, notify your leader or foreman.

6. See that no unauthorized person touches the engine room telegraph. If the telegraph must be worked on, see that the engineer on watch understands this, and establish another communication system, such as a telephone.

7. Do not leave the bridge of the ship unless assured by the engineer on watch that there will be no changes in operations during your absence.

8. Enter in the log book, at two-hour intervals of time, the state of the tide, direction and force of the wind, the state of the weather, and the revolutions per minute of the propeller. Note the draft at each shift and record time and nature of any changes in operation of the engines.

9. If, by any chance, the ship should break away from her moorings or leave the pier, notify the engineers. Give the alarm, let go the anchors, and stand by.

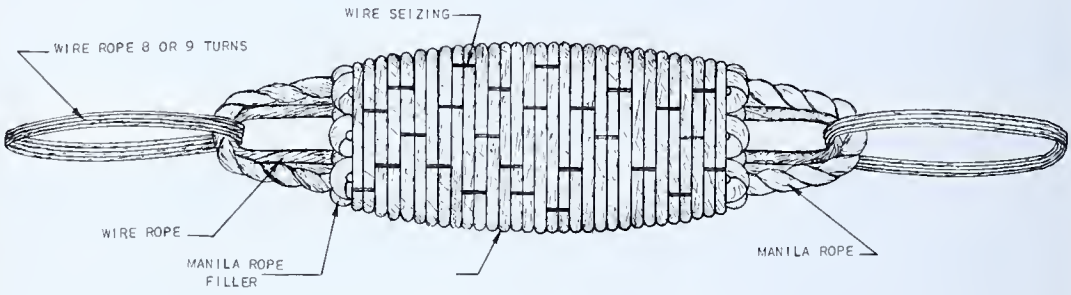


FIG. 205 — *A Fender.*

Types of Fenders

Fenders are pads used to keep a ship from rubbing against the pier or another ship. There are many different types of fenders and they are made of many different kinds of material, such as hickory poles, cane, wood piling, wire and Manila rope. Some fenders consist of canvas bags filled with pulverized cork and are used on lifeboat griping spars and as drop fenders for yachts moored alongside docks and piers.

Wooden floating fenders are used alongside docks or between ships moored beside each other. They are made fast with a lanyard or wire rope reaching to a cleat or some other suitable place on the ship's deck or on the pier.

Fenders made of old wire rope are covered with Manila rope to prevent chafing the ship when it rubs against the dock or another ship. The ability of such fenders to withstand heavy wear is dependent on their bulk and the thoroughness with which they are made. Numerous turns of wire must pass through them from end to end, and the center should be packed or filled with a quantity of Manila rope to give the shape of a fish. The filling at the center of the fender is more important than at the ends.

A rope fender is used at the corner of a pier for a ship to land on and break around the pier, or for use at the head of a pier as a bow fender.

When used as a bow fender, it is attached to the pier in such a position that the bow of the ship may rest against it during engine and propeller dock trials. When used at the corner of a pier, it is bent in the shape of an "L" so that it will fit around the corner.

This type of fender is generally about 12 feet in length, 3 feet in diameter, and filled at the center with extra turns of Manila hawser. It is supported both lengthwise and crosswise by wire rope drawn taut to give it strength. Only worn and partly damaged wire ropes and hawsers are employed to make up these fenders. A large number of seizings are placed at different intervals to give additional strength to each turn of rope.

Wire clamps should not be used, since they are apt to mark or scar the shell plating of the ship when they rub against it.

When fenders are installed on the corners or at the heads of the basins, they are kept high so that their usefulness will be assured. If allowed to drop, they turn under the pier and become ineffective. They should be installed near the top of the pier about one foot from the top or "cap log".

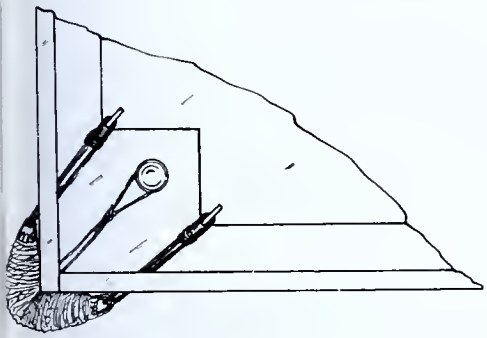


FIG. 206 — *Top View of a Pier Corner Fender.*

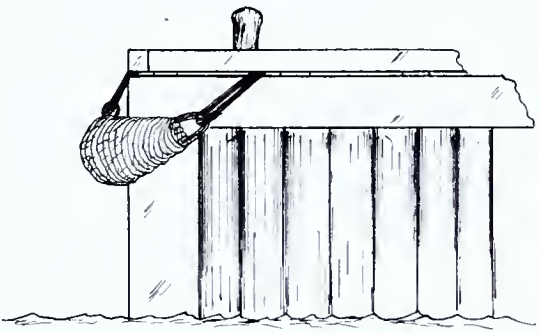


FIG. 207 — *Side view of a Pier Corner Fender.*

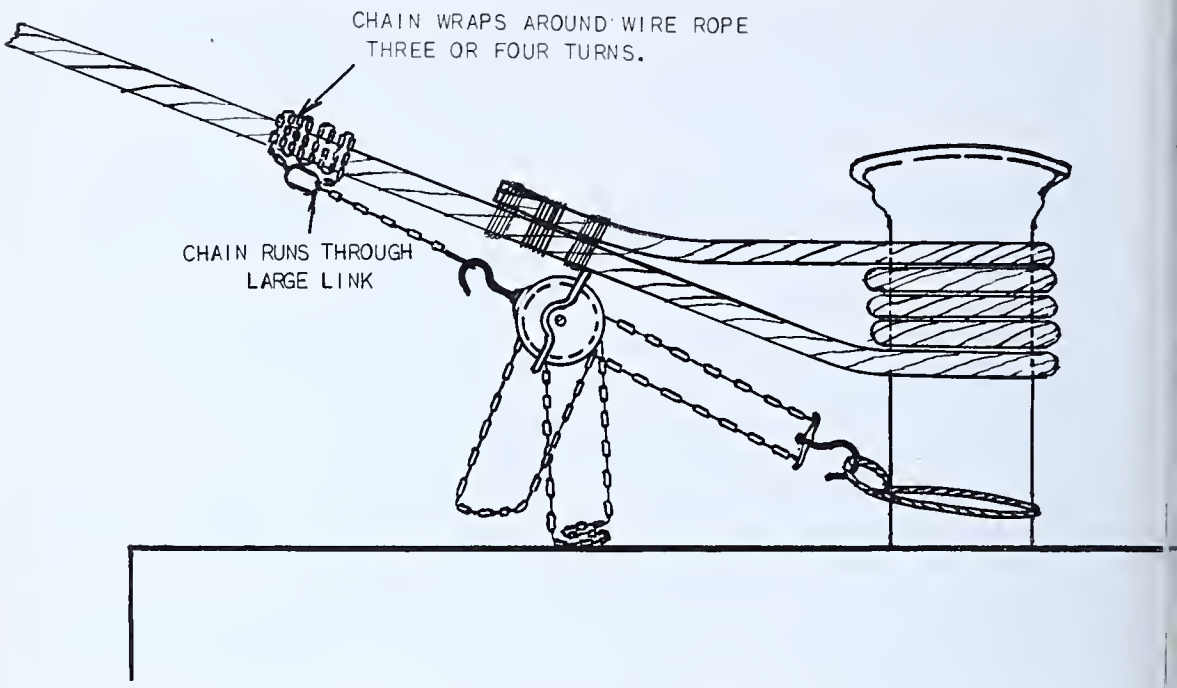


FIG. 208 — *In this drawing the chain is shown single, as it is most generally used.*

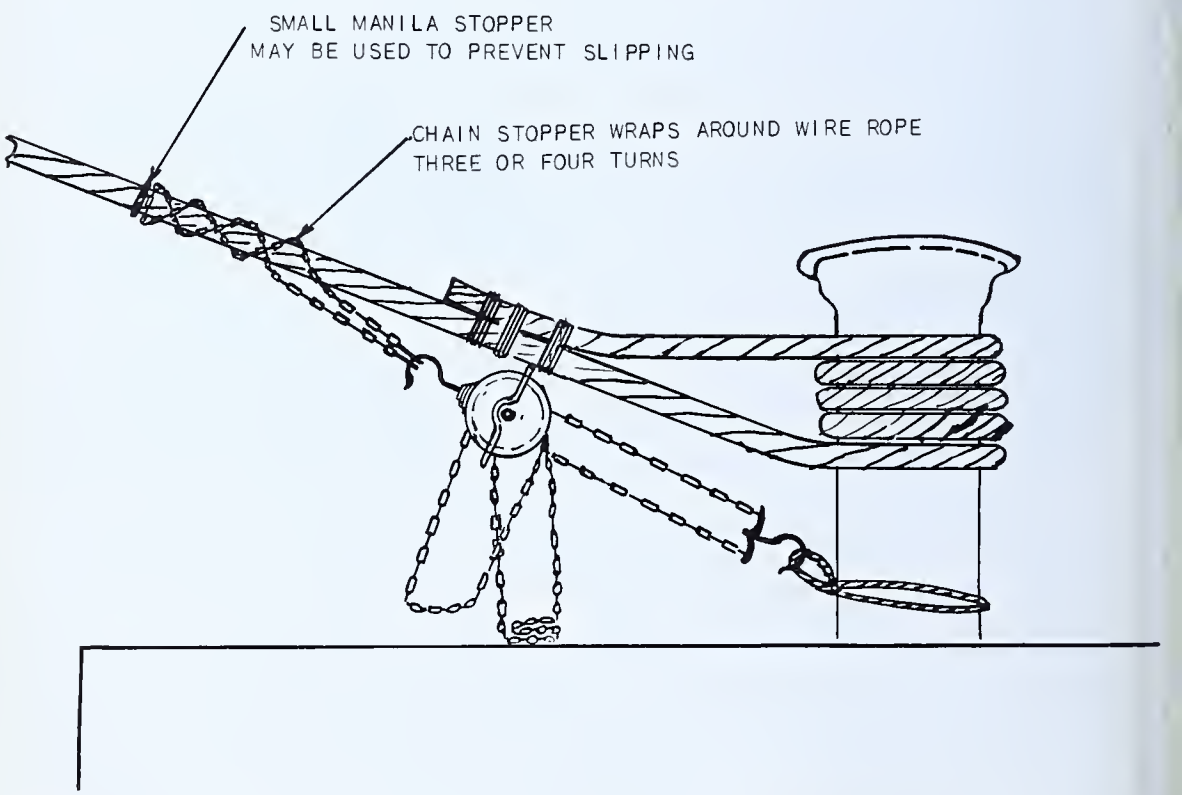


FIG. 209 — *The strength of the chain stopper is doubled when used in this manner, but care must be taken to jamb the turns on the wire. It may be necessary to use a small Manila stopper. The chain hoist shown above or a block and fall is used in the manner shown so as to make tight the heavy mooring wires used on large ships.*

FIG. 210 — *A Chain Stopper.*

FIG. 211 — *A Single Rope Stopper (First Step)*

How to Pass a Chain Stopper

A chain stopper is used to hold a wire rope in a certain position.

PROCEDURE

1. Wrap the chain around the wire rope in three or more half hitches.
2. Make the chain fast with a piece of Manila rope.

How to Pass a Single Rope Stopper

A single rope stopper is made by using a piece of Manila rope with an eye spliced in one end.

PROCEDURE

1. Place the eye over a bitt or some solid part of the ship.

FIG. 212 — *A Hawser Made Fast with a Single Rope Stopper.*

2. Take half a rolling hitch, then one half hitch and back to the bitter end of the stopper.

The hawser is now made fast, or stopped, to the bitt or bollard. After the hawser is secured the stopper is removed.

QUESTIONS

1. **What are the sizes of wire rope used for mooring wires?**
2. **What kinds of lines are used in tying up a ship at a dock?**
3. **Why do ramps and gangways have to be watched and checked frequently when a ship is moored at a pier where the bow cannot be placed against the bulkhead?**
4. **What is the purpose of a splash plate?**
5. **When a ship is being moored, what are the positions of the four six-men gangs?**
6. **What machines, tools, and equipment are necessary to move a ship from berth to berth?**
7. **Why is it necessary to get hold of the ship quickly when it is in position to be moored?**
8. **When are mooring lights required on a ship?**
9. **When should a ship be moved by winch wires?**
10. **What is the best time for moving a ship from berth to berth?**
11. **Why should mooring lines be slacked off when the ship is moored at low tide?**
12. **Why is it necessary to place additional lines on a ship before a dock trial?**
13. **Who should be notified if the ramp gangway needs adjusting?**
14. **How often is the state of the tide entered in the log book during a dock trial?**
15. **If the ship should break away from its moorings, who should be notified?**
16. **What are fenders and for what are they used?**
17. **Why should wire rope fenders be covered with Manila rope?**
18. **What is the purpose of a corner fender?**
19. **Where should a corner fender be installed?**
20. **When should a chain stopper be used?**
21. **What is a rope stopper and where should it be used?**

[25]
HANDLING ANCHORS AND ANCHOR CHAIN

How to Install Anchor Chains

General Information

Studded-link chains are used for anchor chains and the sizes vary according to the size of the ship. The sizes are generally 2¼", 2 5/16" and 2⅜" studded-link chain.

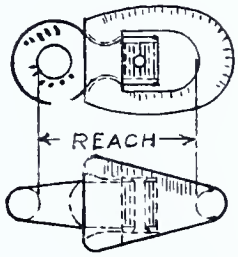


Fig. 213 — *Mooring Swivel.*

A mooring swivel (Fig. 213) is attached five links from the anchor end by means of a detachable link (Fig. 214). This permits the anchor to turn without twisting the anchor chain when the anchor is being lowered or raised.

Particular care should be used when installing anchor, anchor chain, tow and stream wires that the certificate number on the anchors and chains coincides with the identification number on the shots of chain, connecting links, anchors and wires. The inspectors of

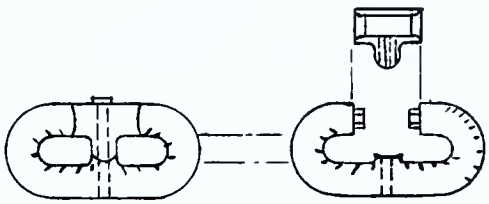
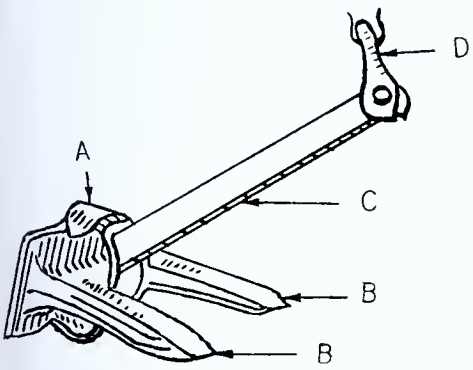


Fig. 214 — *Detachable Link—Open and Closed Views.*



Anchor Parts

A. Crown

B. Palms, or Flukes

C. Shank

D. Anchor Shackle or Jew's Harp

Fig. 215 — *A Baldt Anchor.*

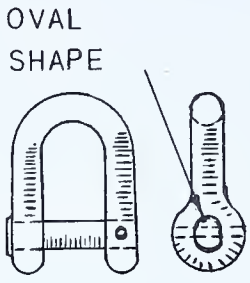


FIG. 216 — *A Joining Shackle.*

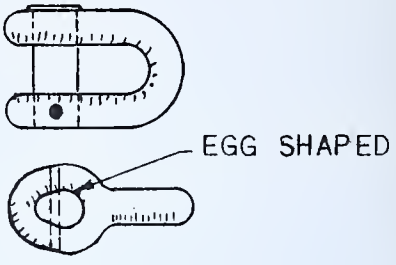


FIG. 217 — *Jew's Harp.*

the various classification societies, such as the American Bureau of Shipping, Lloyds Register of Shipping, and Coast Guard Marine Inspection, should be notified a day in advance so that they may be on hand to make their inspections of the securing of the bitter end of the anchor chain in the chain lockers, and of the make-up of the connecting links and chain markings at the different shots.

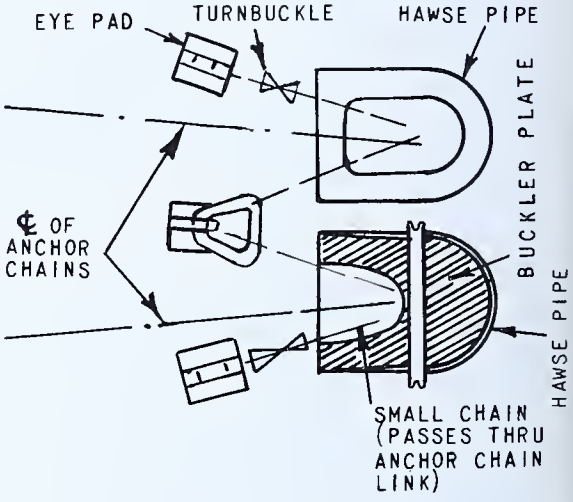


FIG. 218 — *Anchor Lashing.*

Studded Cable Chain

The ultimate breaking strength of a chain with studded links is less than that of an unstudded chain. The principal function of the stud is to prevent the chain from kinking and catching, so that it will run free from chain lockers, etc. The stud also prevents the chain from becoming rigid under heavy strains.

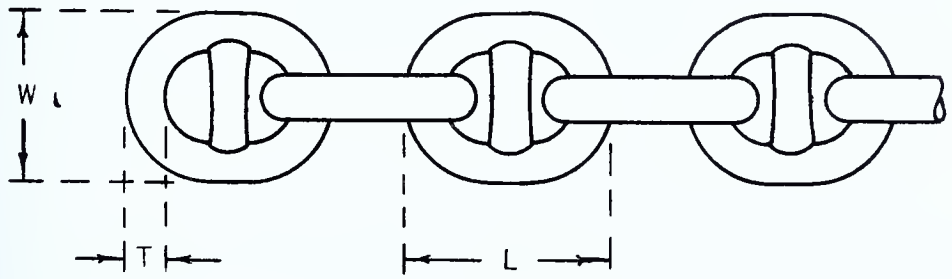


FIG. 219 — *Studded Cable Chain.*

Table XXXIX

DIMENSIONS AND SAFE LOADS FOR STUDDED CABLE CHAIN

Size of Chain in Inches	Length of Link in Inches	Width of Link in Inches	Weight Per Foot of Chain	Safe Working Loads
T	L	W	Pounds	Tons
3/4	4 3/8	2 3/4	5.5	5.05
13/16	4 3/4	3	6.3	6.0
7/8	5	3 1/4	8.2	6.85
15/16	5 3/8	3 1/2	9.2	7.85
1	5 7/8	3 3/4	10.2	9.0
1 1/16	6 1/4	3 7/8	11.5	10.15
1 1/8	6 1/2	4 1/8	12.3	11.4
1 3/16	6 3/4	4 1/4	13.5	12.75
1 1/4	7 1/8	4 1/2	15.0	14.05
1 5/16	7 3/8	4 5/8	16.2	15.5
1 3/8	7 3/4	4 7/8	18.3	17.0
1 7/16	8 1/8	5 1/8	18.8	18.6
1 1/2	8 1/2	5 3/8	21.2	20.25
1 9/16	8 7/8	5 5/8	23.8	22.
1 5/8	9 1/4	5 7/8	25.0	23.75
1 11/16	9 5/8	6	26.2	25.6
1 3/4	10	6 1/4	28.8	27.6
1 7/8	10 1/2	6 3/4	33.8	31.65
1 15/16	10 3/4	7	35.8	33.75
2	11 1/8	7 1/4	38.8	36.0
2 1/16	11 1/2	7 1/2	42.3	38.25
2 1/8	12	7 3/4	46.0	40.6
2 3/16	12 1/2	8	48.3	43.05
2 1/4	13	8 1/4	50.0	45.5

How to Install Anchor Chain

PROCEDURE

1. Check with rigging foreman about the requirements of the American Bureau of Shipping and Lloyds Register concerning chain markings.
2. Place the 20 shots of anchor chain — 10 shots on the port side, 10 shots on the starboard bow — (a shot is 15 fathoms or 90 feet) under and ahead of the ship's bow, laid out with joining links made up and ready for installing. A mixture of lead and tallow is applied to the parts of a connecting link so that it will be easily disconnected when necessary.
3. Have power (electric, steam or air) connected to the windlass and ready for use.
4. Make sure that the chain locker is clear of staging, that it has been painted, that the bottom has been cemented, and that the pipe suctions have been installed.
5. Notify classifications societies of time of installation (a day ahead).
6. Pass a $\frac{3}{4}$" wire messenger down through the hawse pipe.
7. Shackle messenger to the chain locker end, ready for heaving in.

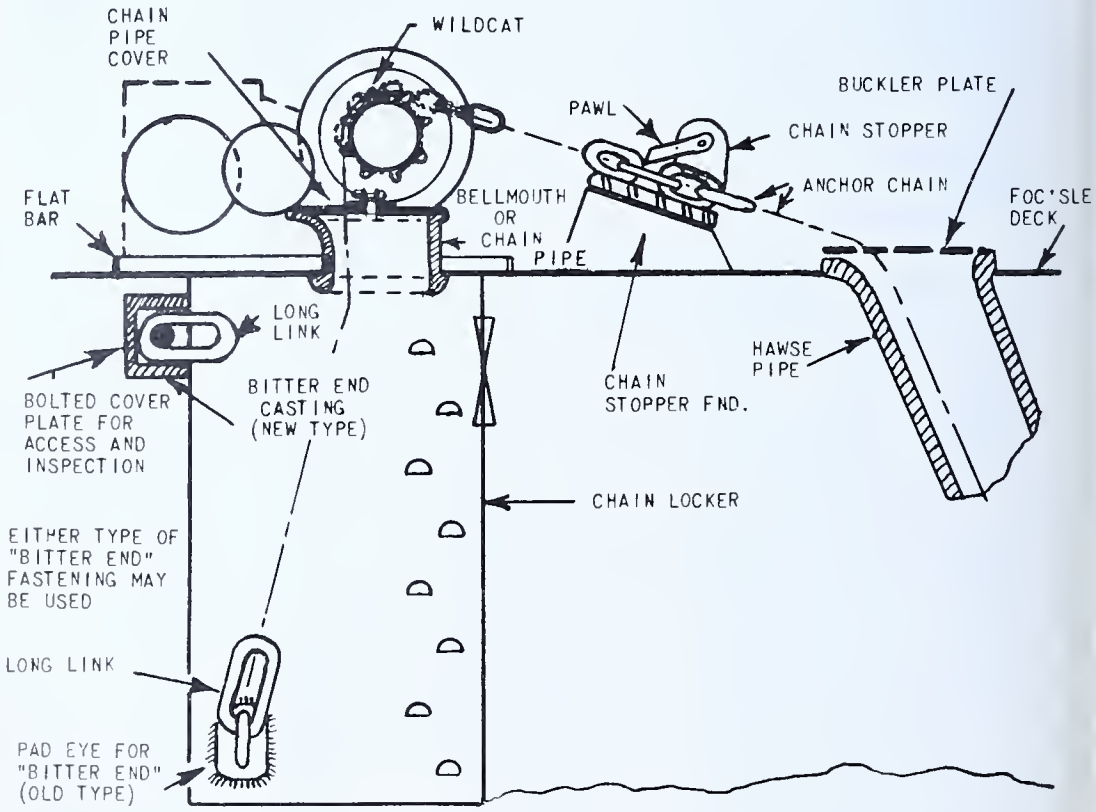


FIG. 220

8. Take messenger to winch head of the windlass, using a snatch block if necessary.

9. Heave away on messenger until the links start over the wildcat of windlass; then lock windlass and heave in chain until the bitter end reaches bottom or place where chain is made fast with a shackle or steel toggle. The shots are marked as the chain comes in, starting with 9, 8, 7, 6, etc. The markers are 2 turns of $\frac{1}{8}''$ seizing wire at the marking links for the different shots of chain.

10. Paint the marker link white or aluminum so that it will show how much chain is in the water when the anchor is lowered.

11. Make sure not to connect anchor until last shot is free of all turns.

12. Tighten brake band on windlass; then unlock wildcat. The windlass is then free to turn niggerhead to moor the ship with Manila.

13. Anchor is now in position to let go.

QUESTIONS

1. **What kind of chain is used for anchor chain?**
2. **What is the function of a mooring swivel?**
3. **What is the advantage of a detachable link?**
4. **How is anchor chain marked? Why is it marked?**
5. **What care should be taken before connecting the anchor to the anchor chain?**
6. **Who is notified when the chain is ready for installation?**
7. **How many feet of chain are there in a shot?**
8. **What is the most efficient procedure for installing chains that connect links and anchors.**

[26]
STEPPING A MAST

General Information

A mast is ready for stepping on the ship when all piping and electrical cable has been installed on it. The fitters should be notified in advance to have the mast doubler and all deck pads placed. The temporary guys and tackles should be on the mast and ready for use.

Sometimes the mast-light brackets have to be removed to prevent damage to them.

The mast should be stepped at low tide if the greatest lifting height of the crane is required. This arrangement is necessary only in the wet basins where the effect of rise and fall of tide is encountered.

A mast will weigh from 8 to 10 tons.

All cargo booms, king posts, and king-post booms are placed about the deck on tankers where they will be most convenient for handling hoses, cargo, gangways, engine equipment, and stores. Booms and king posts range in capacity up to 30 tons.

On cargo ships the king post and boom layout is designed to give quick and safe cargo handling in and out of the hatches. Cargo handling gear consists of electrically operated deck winches, cargo falls, blocks, booms, topping lifts, king posts, standing rigging, and running rigging guys. On the ends of the cargo falls, various types of cargo hooks are used. Most of them are the Seattle type.

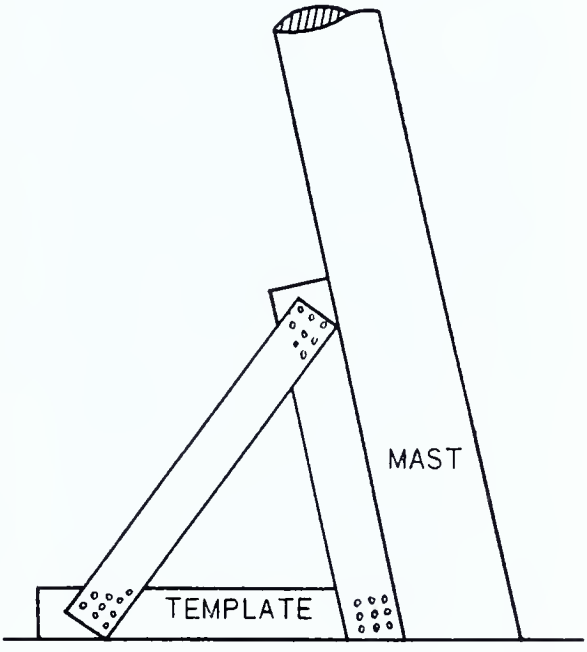


Fig. 221

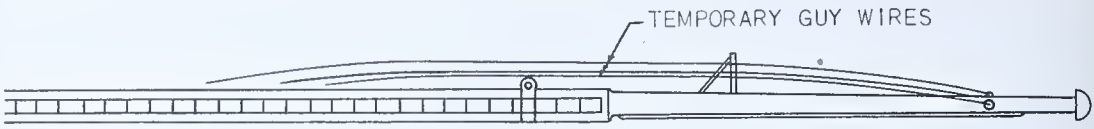


FIG. 222 — *Showing the Temporary Guy Wires Fastened to the Mast.*

TOOLS AND EQUIPMENT

10-ton lashing ring or a special mast stepping pendant
Pendants
Crane of suitable size

PROCEDURE

1. Lash a 10-ton lashing ring or snare a pendant around the mast above the balance point, or use the pads on the mast.
2. Hook the crane to the mast and mouse the crane hook. Then swing the mast up over the deck and locate it in its proper place.
3. Land the mast lightly in position.

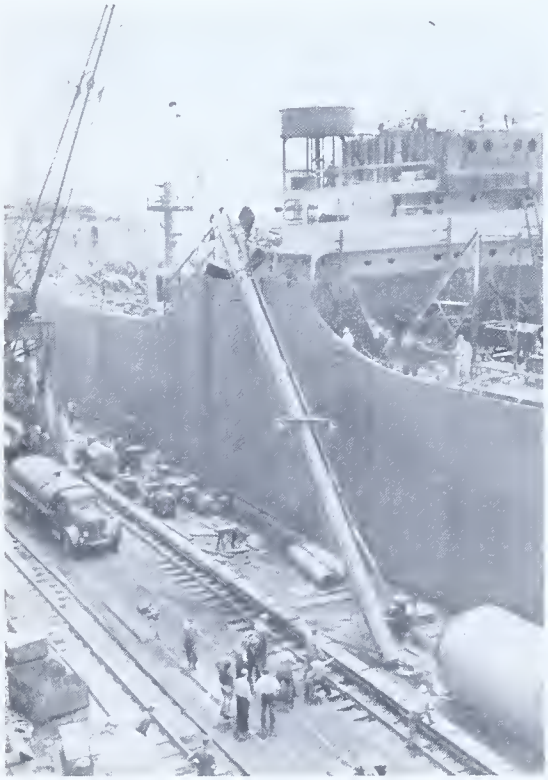


FIG. 223 — *Lifting a Mast from the Pier with a Gantry Crane.*

FIG. 224 — *Landing a Mast on Deck with a Gantry Crane.*

4. Line it up between the lining-up pads and wedges on the deck.
5. Establish the rake of the mast by use of a rake template as shown in Fig. 221.
6. Release the crane.
7. Secure the temporary guys and tackles to various convenient places on deck.
8. Install the permanent rigging as soon as possible, because the temporary guys are not dependable and serious danger might result from cutting the temporary guys adrift.
9. When ships are berthed at piers where the crane boom may strike them, red lights should be strung to the mast trucks on the truck halyard to warn the crane operator, at night, not to swing into it.

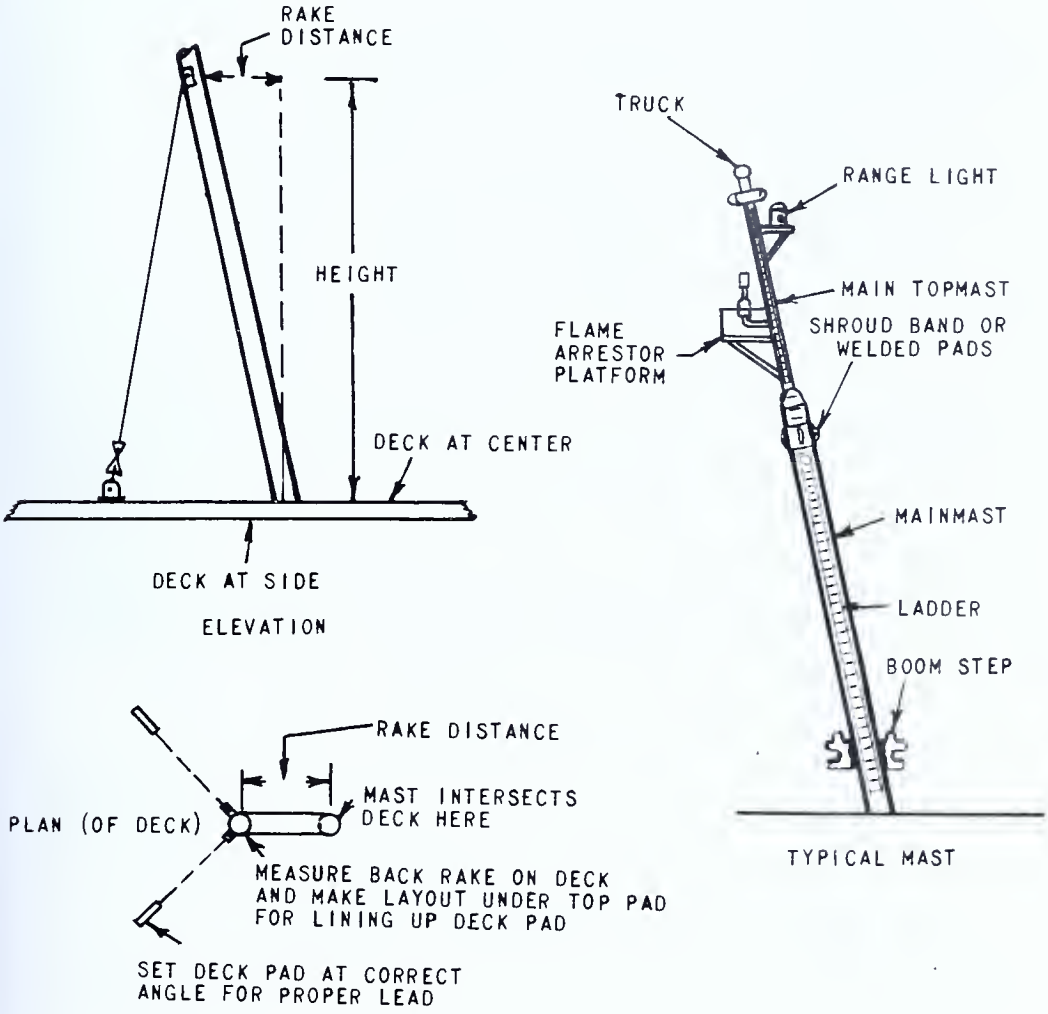
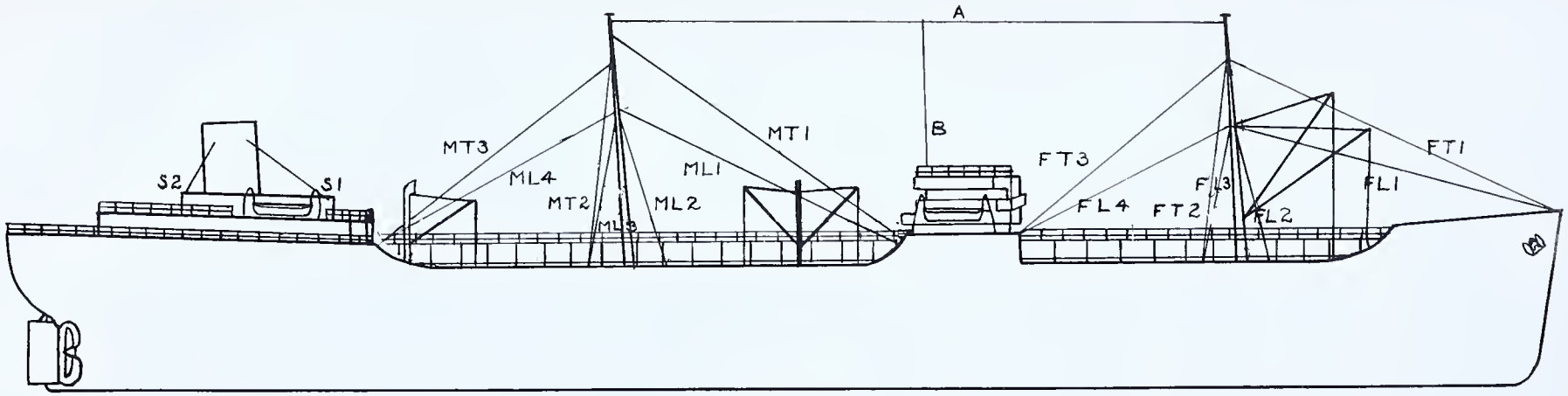
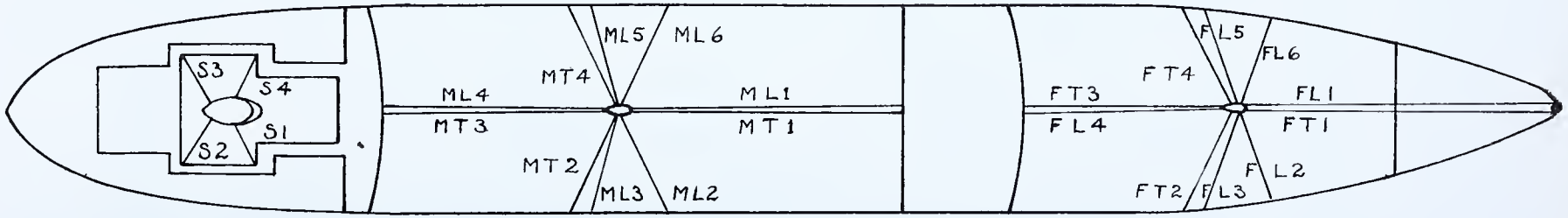


Fig. 225



Port Side View



Deck View

S1, S2, S3, S4 — Smokestack Guys
ML1 — Main Lower Forestay
ML2 — Main Starboard Forward Shroud
ML3 — Main Starboard After Shroud
ML4 — Main Lower Backstay
ML5 — Main Port After Shroud
ML6 — Main Port Forward Shroud

MT1 — Main Fore-topmast Stay
MT2 — Main Starboard Topmast Side Stay
MT3 — Main-topmast Backstay
MT4 — Main-topmast Port Side Stay

FL1 — Fore Lower Stay
FL2 — Foremast Forward Starboard Shrould
FL3 — Foremast After Starboard Shroud
FL4 — Foremast Lower Backstay
FL5 — Foremast After Port Shroud
FL6 — Foremast Forward Port Shroud

FT1 — Fore Topmast Stay
FT2 — Fore Starboard Topmast Side Stay
FT3 — Fore-topmast Backstay
FT4 — Fore Port Topmast Side Stay

A — Antenna
B — Lead-in Wire for Antenna

FIG. 226 — *Standing Rigging*

QUESTIONS

1. **When is a mast ready to be stepped?**
2. **For what is a rake template used?**
3. **When should a mast be stepped at low tide?**
4. **When and why are red lights strung to the mast trucks on the truck halyard?**
5. **What equipment is required for stepping a mast?**
6. **How much does a mast usually weigh?**

How to Install Standing and Running Rigging

PROCEDURE

1. Send aloft a gantline consisting of a sufficient length of rope and a 6″ single wood block. See Shipyard Rigging Terms and Definitions at the back of this book.
2. Heave a man aloft, in a boatswain's chair, in such a position that he can handle the rigging aloft when it is heaved up to him.
3. Have men on deck bend on the shrouds with an extra gantline and hoist rigging up to the man who is waiting ready to shackle the rigging to the mast.
4. When all rigging is hung, lower the man to the deck and have the leader and his men connect the lower ends of the rigging to the deck pads with turnbuckles.

During the final stages of the ship's construction, the turnbuckles on the rigging stays are set up tight and secured.

QUESTIONS

1. **What is a shroud?**
2. **What is a stay?**
3. **What is the difference between a shroud and a stay?**
4. **What is the difference between a back stay and a side stay?**
5. **What is a lead-in wire?**
6. **For what are smokestack guys used?**

[27]
DECK MACHINERY AND CARGO GEAR

Testing Cargo Handling Gear

When a ship is nearly completed and when all the masts, booms, deck winches, cargo boom topping lifts and vangs are installed, and the ship's own generators are operating to provide power, all the cargo handling gear and deck machinery is tested, according to specifications of the owners and builders.

The various sets of booms and radii of booms are arranged for by the loft riggers, who conduct detailed tests called for by the test sheet and witnessed by the owners' inspectors, representatives of the American Bureau, Lloyds Register, and the builders. These tests usually include sufficient over-loading of incidental equipment, mast booms and winches, so that the cargo-handling gear used by the sailors or stevedores in loading and unloading the ship will have the proper safety factors.

PROCEDURE

1. Set up tight all shrouds and stays.
2. Top or hoist booms 15° from horizontal position.
3. Set boom over the load.
4. Hook or shackle load to cargo runner and heave up and down with a winch.
5. Pull and jerk load by hoisting it as far as possible, release brake, then catch load on brake before touching deck or ground. Repeat according to test specifications.

Test Specifications*

Every crane and other hoisting machine with its necessary gear shall be tested with a proof load which shall exceed the safe working load according to the following table:

*The test specifications listed in this information sheet are taken from the American Bureau of Shipping Specifications.

Safe Working Load	Proof Load
Up to 20 tons	25 per cent in excess
20 - 50 tons	5 tons in excess
Over 50 tons	10 per cent in excess

The proof load shall be hoisted and swung as far as possible in both directions. In the case of a jib-crane, if the jib has a variable radius it shall be tested with a proof load as defined above at the maximum and minimum radii of the jib. In the case of hydraulic cranes or hoists, where, owing to the limitation of pressure, if it is impossible to hoist a load 25 per cent in excess of the safe working load, it shall be sufficient to hoist the greatest possible load.

Every article of loose gear (whether it is necessary to a machine or not) shall be tested with a proof load at least equal to that shown against the article in the table given in the specifications above.

Operating and Testing a Winch

There are two kinds of winches in common use: electrically operated, and steam operated. They are the same, except for the way each is powered.

The electric winch is controlled by a rheostat. Generally, when the hand lever is in the center it is in neutral. The winch turns in one direction when the lever is switched to the left, and in the opposite when switched to the right.

When the control lever is in neutral an automatic brake stops and holds the load.

The steam driven winch is operated by a lever which is in neutral when vertical. When the lever is pushed forward, the winch turns in one direction, and when pulled back, the winch turns in the opposite direction.

Test Specifications

Every winch, with the whole of the gear accessory to it (including derricks, goosenecks, eye plates, eyebolts, or other attachments), shall be tested with a proof load which shall exceed the safe working load according to the following table:

Safe Working Load	Proof Load
Up to 20 tons	25 per cent in excess
20 - 50 tons	5 tons in excess
Over 50 tons	10 per cent in excess

The proof load shall be applied either (1) by holding movable weights, or (2) by means of a spring, hydraulic balance or similar appliance, with the derrick at an angle with the horizontal which shall be stated in the certificate of the test. In the first case, after the movable weights have been hoisted the derrick shall be swung as far as possible in each direction. In the second case, the proof load shall be applied with the derrick swung as far as practicable, first in one direction and then in the other.

Test for Booms Rated at 5 Tons Safe Working Load

(1) Test the operation of both the electrical and mechanical brakes on each winch. Demonstrate the ability of both the electrical and mechanical brakes to hold the load (7450 lbs.) during either hoisting or lowering.

(2) Demonstrate the effectiveness of the electric brake to land loads (7450 lbs.) without jarring or inching on one winch of each size and type. On the double-geared winch make this test with each gear.

(3) Test each winch of each size for five complete cycles through maximum obtainable drift when handling a load of 11,200 lbs. Record power data indicated on data sheets.

(4) Test each winch of each size. Swing load (14,000 lbs.) inboard and outboard as far as obstructions will permit with the boom at an angle of 15° to the horizontal.

(5) Test one boom at each hatch by lowering the load (14,000 lbs.) to the tank top and back again.

(6) Test one winch of each size to handle the specified loads at specified rope speeds in accordance with the following schedule:

Light Duty Winch

3720 lbs.	290′/min.
7450 lbs.	220′/min.

Heavy Duty Winch

7450 lbs.	235′/min. high gear
7450 lbs.	105′/min. low gear

(7) Test one winch with a load of 7450 lbs. and at a rope speed of about 175′/ min., raising and lowering the load continuously for 30 minutes. The load shall be stopped in the hold 20 seconds each time. During this test, check the heating of the rheostat.

How to Test a Capstan

PROCEDURE

1. Place the steel billets abreast the capstan (with a crane).
2. Place 18″ single sheave steel blocks on the main hoist of the crane.
3. Protect the main hoist with a 1¼″ preventer to represent a backer; lead across the pier to a mooring post or to bitts and secure it there.
4. Reave a 1¼″ plow steel wire through the 18″ single block.
5. Take the bitter end to the capstan.
6. Shackle the eye of the wire rope to the load.
7. Heave load up and down.

Specifications for a Capstan Test

1. Record the bight-line speed on each point of the controller in both a clockwise and counter-clockwise direction.
2. Support a static load of 40,000 pounds.
3. Hoist and lower the load of 20,000 pounds at a rope speed of 36 R.P.M. while making the test.
4. Test the operation of the brakes at a speed of 36 R.P.M. while making this test.
5. Test the operation of the brakes and their ability to hold the load.
6. During the test, record the power input indicated on data sheets.

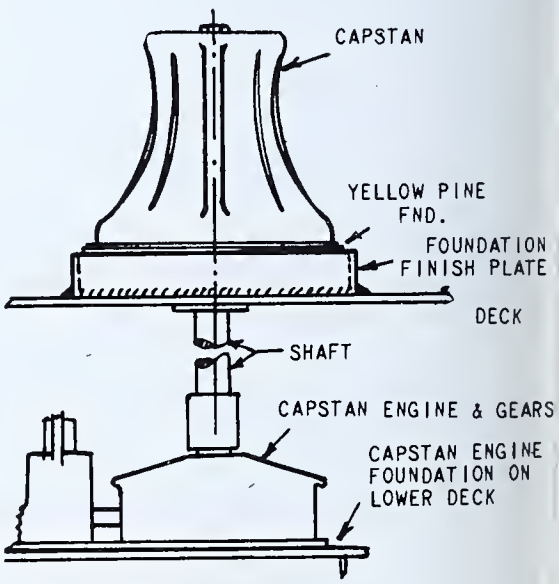


FIG. 227 — *Capstan.*

How to Sling a Windlass

Two one-inch wire rope pendants twenty-five feet long are used. One is placed around each wildcat with all four eyes up and hooked to the crane. Depending on the size of the windlass, a three- or five-ton chain hoist is hooked on the heavy end to permit the windlass to be slung into place and let down as nearly as possible into its correct position.

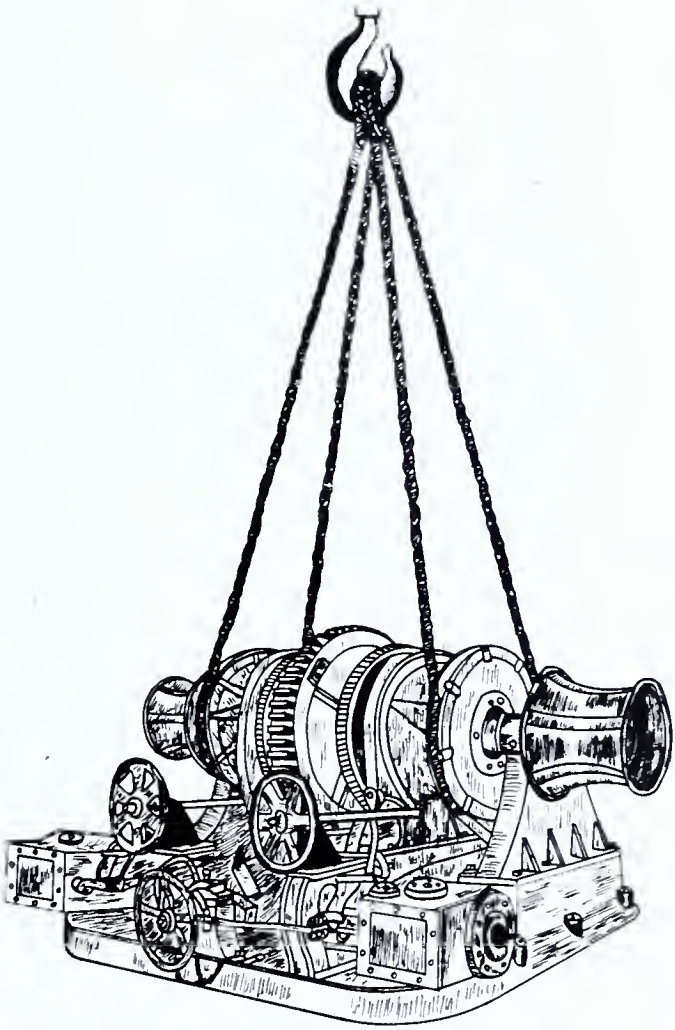


FIG. 228 — *The Pendants in Place for Slinging a Windlass. This type of windlass does not require the use of a chain hoist since the weight is balanced on both sides of the wildcats.*

How to Test an Anchor Windlass

PROCEDURE

1. Lock in the wildcats.
2. Release compressor or brake.
3. Lower and heave the anchor through as many cycles as the specifications of the test require.

Anchor-Test Specifications

1. Raise and lower a load equivalent to 15 fathoms of chain and one anchor (about 14,000 lbs.) continuously for 15 minutes.
2. Raise and lower a load through one complete cycle equivalent to 15 fathoms of chain and two anchors (about 24,000 lbs.). During this test, test the operation of the brake and chain stoppers.

FIG. 229 — *Hauling a Manila Rope Tight, Using an Anchor Windlass Warping Head.*

QUESTIONS

1. **What are the two kinds of winches in common use?**
2. **What is a boatswain's chair?**
3. **When should the turnbuckles on the rigging stays be set tight and secured?**
4. **Why should the ship's own generators be operating when testing cargo handling gear and other deck machinery?**
5. **What is a capstan?**
6. **How is an anchor windlass lifted for placing on a ship?**

[28]
NAVIGATING EQUIPMENT

General Information

The rigging department has charge of equipping and placing all navigating equipment, consisting of a standard binnacle and compass, the after steering binnacle and an azimuth circle; sounding equipment, the log, hand sounding leads; the Lyle gun and equipment; oil and electric navigating lights, out-of-command shapes and lights; code flags, ensigns and company flags; megaphone, etc.

The compass binnacle installation is made by the yard captain.

How to Install a Compass Binnacle

Procedure

1. Place the healing magnet in the binnacle above deck with the north end up, and beneath deck with the north end down.
2. Place the adjusting magnets in the rack, alternating the north and south ends.
3. Place the flinders bars in the rack when provided.
4. Place compensating balls on the arms of the binnacle.
5. When the standard binnacle is placed on a pad or stand aboard a ship, line it up by use of an azimuth circle, taking the bearings on previously placed targets on the bow of the ship.

   When the carpenter is fastening down the binnacle a careful check must be taken with bearings to keep the binnacle in line.
6. Set the wheel house binnacle by taking bearings of shore objects from the standard binnacle and applying the same to the wheel house binnacle.
7. Set the after steering binnacle from the center line of the ship.

Sounding Machine

The sounding machine is usually placed on the ship's deck, under the navigating bridge. A sounding boom must be rigged with such items as a topping lift, a forestay and afterstay, a carrier and a trolley.

The equipment for the sounding machine consists of a feeler, a measuring stick, three cases of sounding tubes, a tube holder and three leads. It is used for measuring the depth of water.

The log consists of a boom fitting, recorder, rotor, governor, hook and line. It is used for recording the speed of a ship through the water.

Leads

There are three different sizes of leads in common use:

1. The boat's lead which weighs from 5 to 7 pounds.
2. The hand lead which weighs from 7 to 14 pounds.
3. The deep sea lead which weighs from 15 to 75 pounds.

The Hand Lead Line

The hand lead line is made up of 25 fathoms of hemp or waxed cotton.

On a hand lead line, the points representing the various fathoms are known as marks and deeps. The marks are the fathoms marked by pieces of leather or rags; the deeps are the fathoms which are not marked.

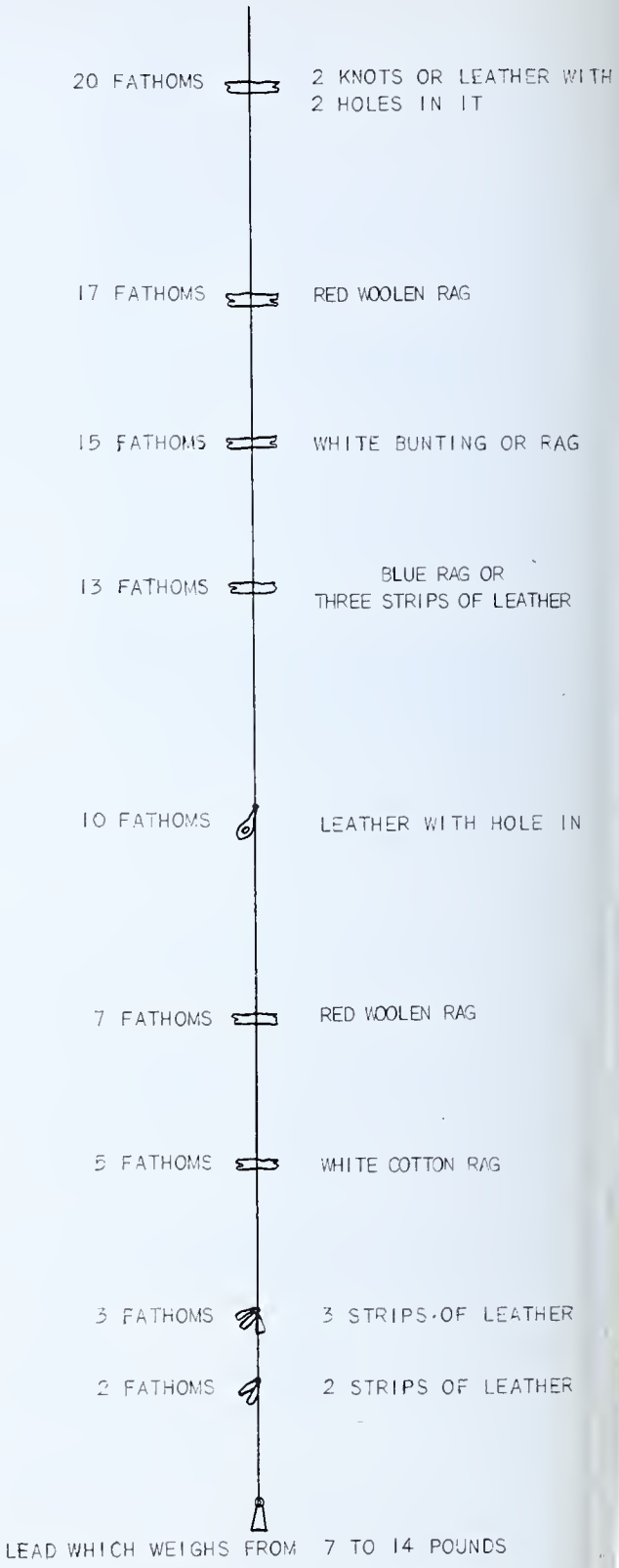


FIG. 230 — *A Lead Line.*

The hand lead line has 9 marks and 11 deeps and is marked as follows:

2 fathoms, two strips of leather.

3 fathoms, three strips of leather.

5 fathoms, white cotton rag.

7 fathoms, red woolen rag.

10 fathoms, leather with one round hole.

13 fathoms, same as 3 fathoms.

15 fathoms, same as 5 fathoms.

17 fathoms, same as 7 fathoms.

20 fathoms, leather with two round holes.

The marks 7 and 17 fathoms should be red woolen or bunting rag, and the marks 5 and 15 fathoms should be white cotton or linen rag so they may be distinguished at night by feeling.

The line should be thoroughly wet before marking.

How to Bend the Lead Line to the Lead

PROCEDURE

1. Pass the bight of the eye of the line up through the grommet on the lead and over the end of the lead and pull taut. The knot formed with the eye of the grommet and the eye of the lead line will lock the same as a reef or flat knot, sometimes called a square knot.
2. Parcel and serve the wire grommet with marline and make a throat seizing around the bight.

   The eye in the lead line is made with three throat seizings when sash cord is used, but if manila rope is used the eye is spliced in the end of the lead line.

FIG. 231 — *Showing a Lead Line Fastened to a Lead.*

Oil Navigating Lights

The following oil lights must be furnished: (one for each location) port, starboard, range, mast head, and stern; two anchor lights, two red lights (out of command), and in some cases two towing lights. All the above lights must be filled with kerosene and ready for use.

Electric Navigating Lights

There shall be two anchor lights and two out-of-command lights. All the rest of the electric lights are taken care of by the electricians.

Not-Under-Command Shapes

These consist of two black balls or shapes 24″ in diameter. Either one may be used as an anchor ball. When two shapes are used they are in a vertical line, one six feet above the other, hoisted aloft where they are clearly visible.

Code Flags

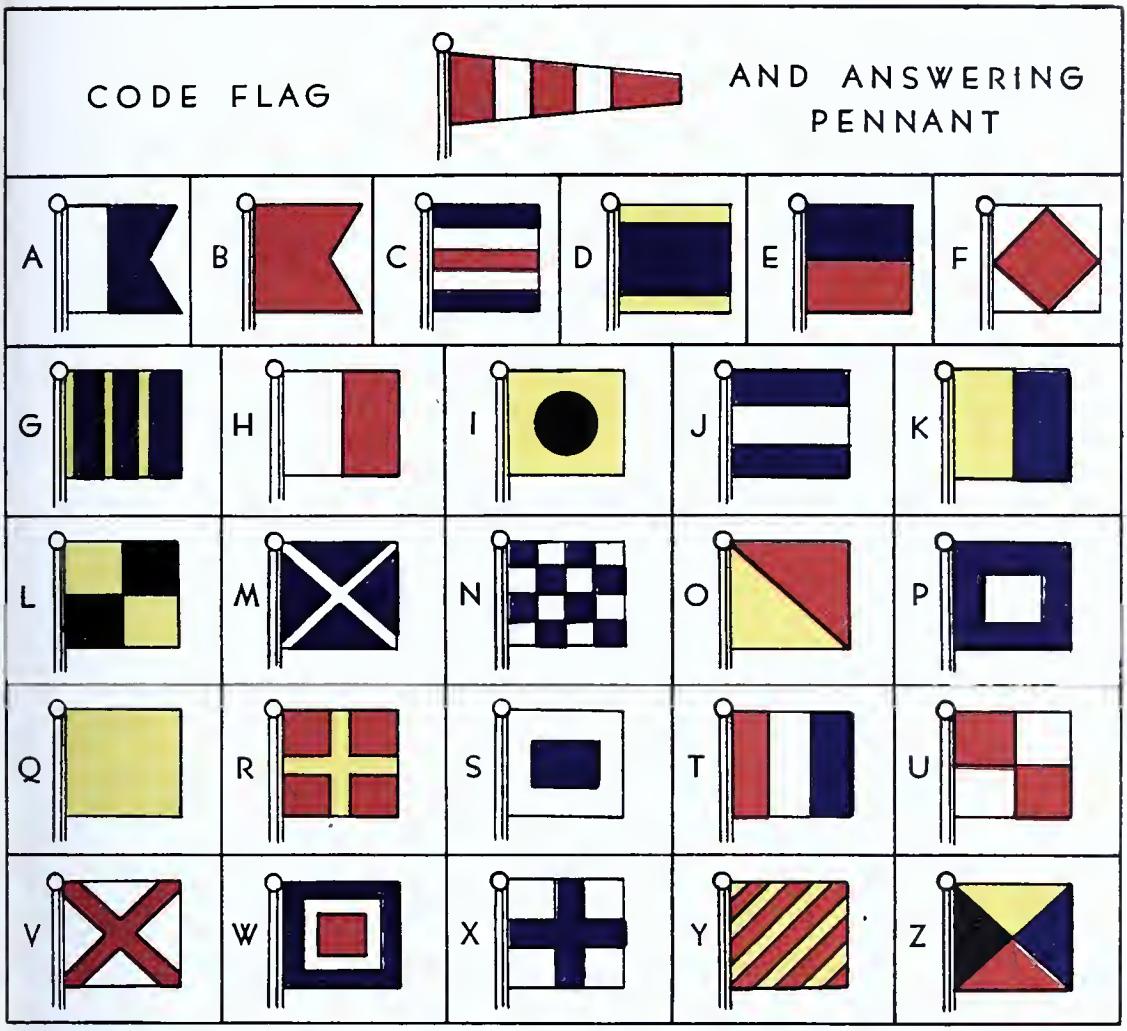
Each ship is furnished with a complete set of code flags, one for each letter of the alphabet and one for each numeral. Each ship also has a code or answering flag and first, second and third substitute flags.

It is the duty of the rigging department to see that all the equipment listed above is placed on board ship and erected or stored in the proper places.

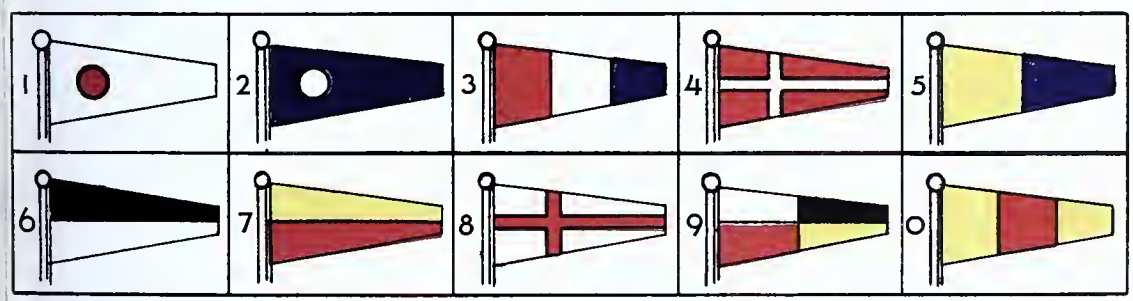
QUESTIONS

1. **By whom is the compass installed?**
2. **What is included in the sounding machine equipment?**
3. **What are out-of-command shapes?**
4. **What are the markings on a hand lead line?**
5. **What part of the riggers' work deals with code flags?**

INTERNATIONAL CODE OF SIGNALS



NUMERAL PENNANTS



REPEATERS

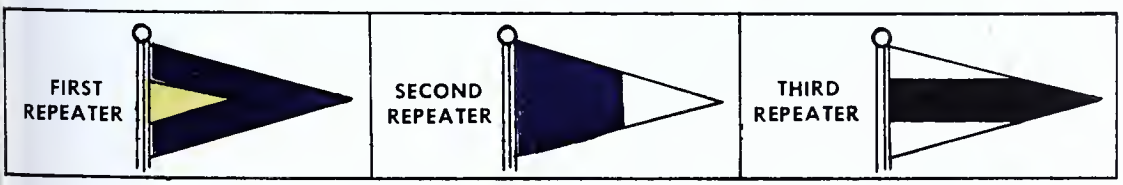


FIG. 232

[29]
LIFESAVING AND FIRE-FIGHTING EQUIPMENT

General Information

A life jacket made of cork or kopak is provided for each member of the ship's crew. Under war regulations these jackets must be grey in color and made of a fireproof material. Extra jackets amounting to 25% of the total crew number are stowed in a box provided for them on the boat deck.

Eighteen life rings, grey and fireproof, must be stored in racks provided; one-half of these life rings shall be supplied with a waterproof flashlight attached to the life ring with one fathom of 12-thread Manila rope. Two of the life rings shall have coils of 15 fathoms of 12-thread Manila rope, one end secured to the life ring. All life rings shall be located conveniently about the deck.

In addition, under war regulations, there shall be two doughnut-type life floats stowed in racks provided, one forward and one aft. With these two floats there shall be provided an electric, waterproof light secured to the float with two fathoms of 12-thread manila.

There shall be a life net and a life ladder made fast on deck at each lifeboat. They must be stowed in such a position as to be lowered over the side of the ship readily.

Four life rafts stowed in inclined racks on the edge of the deck must be provided. They shall be equipped with the following articles: bread breaker with required amount of food; water breaker with required amount of fresh water; watertight can containing two boxes of matches; four oars, four oarlocks, and one spare rowlock; one hook with a yellow signal flag attached; 15 fathoms of 12-thread Manila; one painter of 2½" Manila; one sea anchor, and an oil spreader; one bag of 25 wooden plugs; one graduated cup, and two plain drinking cups; one first-aid kit; one can of distress lights; and two bridles, one at each end, of such length as to meet over the camber of the raft when placed at an angle of 60°.

All these articles must be properly secured to each raft and stowed in their proper places.

There must also be provided for each raft a waterproof light secured to the raft with two fathoms of 12-thread Manila.

Under war regulations a rubber lifesaving suit with a light is provided for each member of the crew.

Lifeboats

The number of lifeboats on a ship depends upon its size and specifications. They are equipped according to specifications, but with special attention paid to the following items:

Bungs must be on the side and on the end of the water breaker.

Bread breakers must be made watertight with a rubber gasket.

Boat hooks must have blunt ends.

Rowing oars must be stowed with handles aft and steering oar with blade aft.

The oil spreader must be non-leakable and full.

The compass must be free of any bubble.

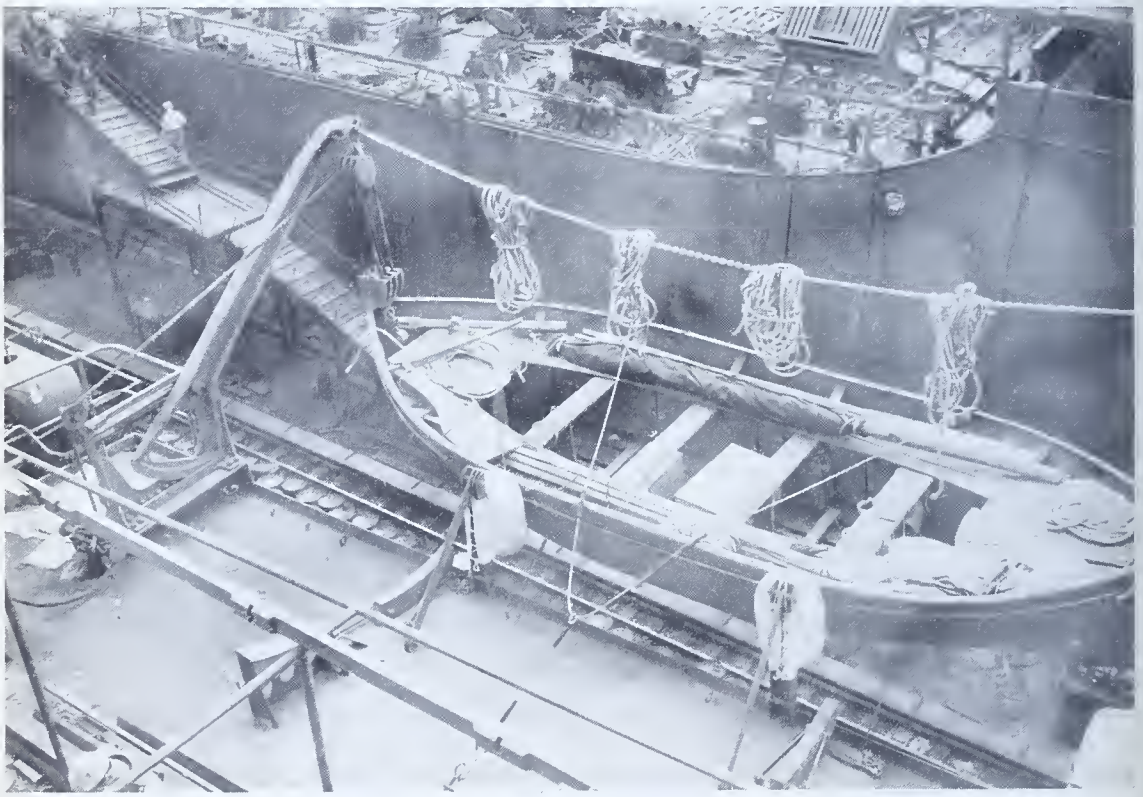


FIG. 233—*A Fully Equipped Lifeboat with Outboard Puddings, Gripes, and Man Rope.*

The bucket is to be stowed open end down.

The lantern must be full of kerosene and the flashlight in working order.

All this equipment must be securely lashed in its proper place.

Lifeboat falls are made up of triple blocks rove with Manila rope 3½" in circumference. They may be larger according to the size of the boat. On boats under 22 feet in length, the three-part and two-part blocks are used; on boats 22 feet and over, three-part and three-part blocks are used. The difference in the weight of boats requires the different arrangements of tackle.

The riggers place the lifeboats on deck either by hand or by means of a crane, depending on the size of the boat and the crane facilities.

FIG. 234 — *A Lifeboat Releasing Gear and Lashing. The Lashing may be cut if the Pelican Hook Fails to Release.*

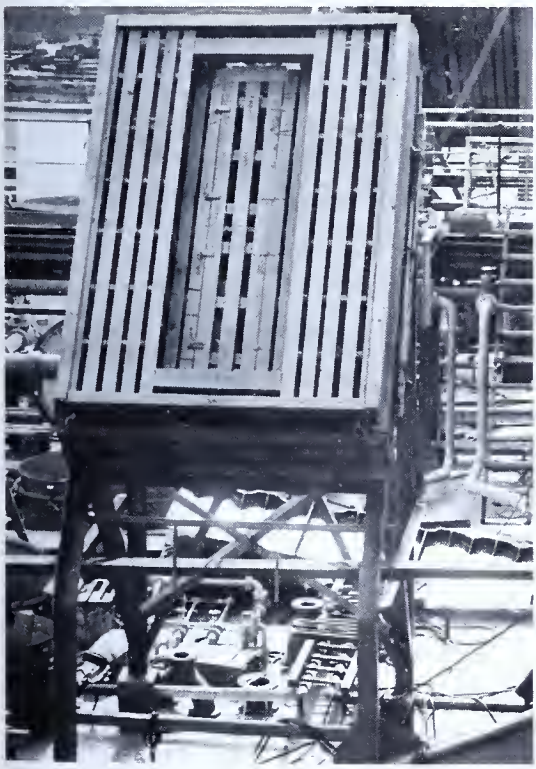


FIG. 235 — *A Life Raft on Skids.*

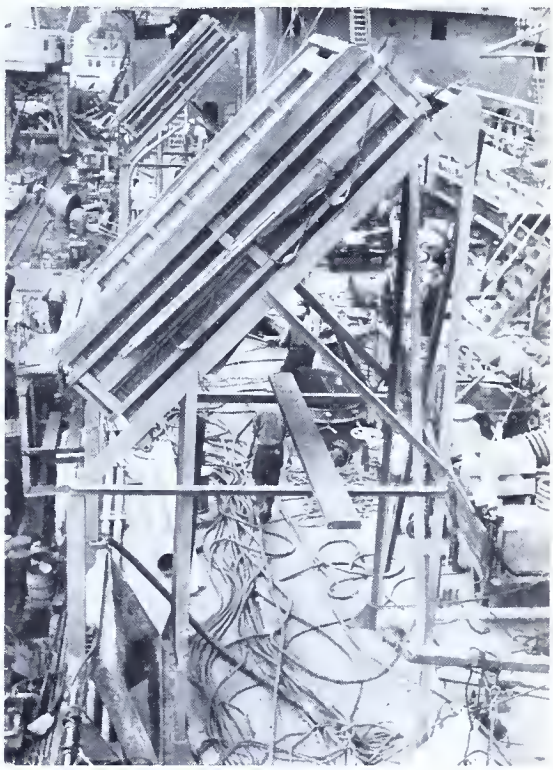


FIG. 236 — *The Side View of a Life Raft Showing the Oars Attached to the Side.*

The Lyle Gun

The Lyle gun and equipment consists of the following:

1500 to 1700 feet of 3″ live Manila rope.
6 metal tubs of 6-thread small shot Manila rope, each rope 1700′ long.
6 steel projectiles.
1 Lyle gun.
25 wads.
25 primers.
6 bags of powder.
1 ram rod.
1 flaking box.
1 breeches buoy.
1 tail block.
1 coil of 2″ live Manila rope.
1 snatch block (wood).
1 firing gun lanyard with wood toggle.

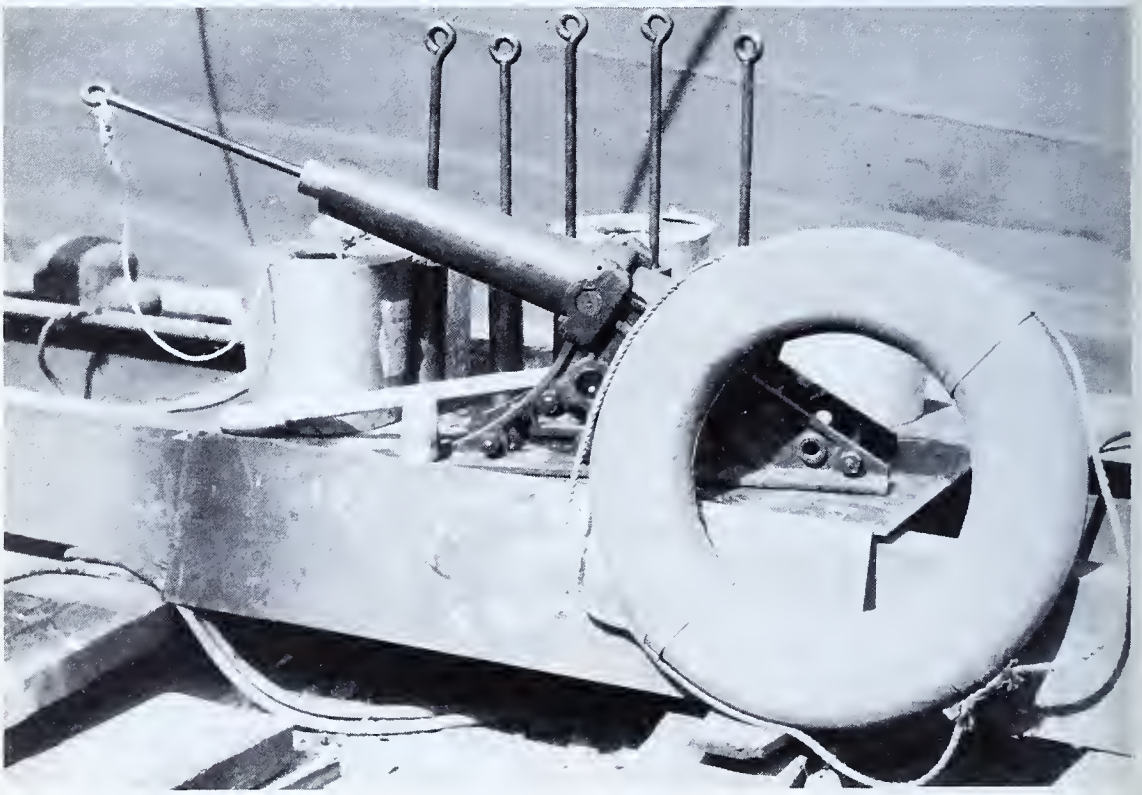


FIG. 237 — *Lyle Gun and Equipment.*

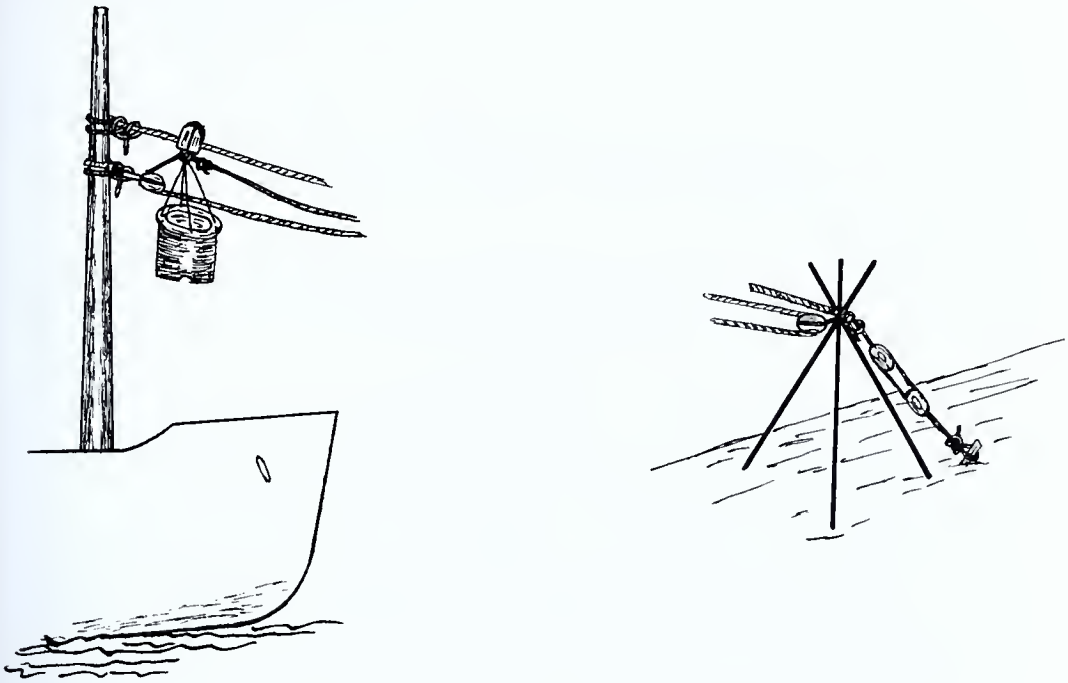


FIG. 238 — *Showing How the Lyle Gun Equipment is Used.*

Fire-Fighting Equipment

The riggers must equip each ship with the following fire-fighting equipment and see that it is in working order and placed according to specifications. The equipment consists of a number of lengths of cotton, rubber-lined hose, 2½″ in dia. and 50′ long; generally 3 lengths of canvas, rubber-lined hose, 1½″ in dia. and 50′ long, for the engine room; and a length of unlined linen hose, 1½″ in. dia. and 75′ long, for taking on fresh water.

Connections for hoses may be any one of various threads according to the specifications. There must be a nozzle to fit each section of hose, and a spanner for each section. These hose hydrants must be conveniently located about the deck, engine room, fire room, etc.

All hoses aboard ship must be tested by coupling one to the other. A reducer is used for the 1½″ hose. One end of the connected sections is attached to a fire line; the other end is plugged. Under the supervision of the steamboat inspector a test of 100 lbs. pressure is put on the hose.

When the hoses have passed the test they are placed in designated racks about the ship.

In most cases the size of the ship determines the number of fire extinguishers to be supplied. They consist of a number of 2½-gallon foamide

extinguishers which are placed in racks throughout the ship. They are filled at the storeroom before installation. There are also a number of Pyrene extinguishers, each holding one quart of carbon tetrachloride, located in designated places, such as radio room, battery room, and motor lifeboats.

A number of extra charges equal to half the total number of extinguishers must be furnished.

A number of fire axes are placed in racks at designated places on the ship.

QUESTIONS

1. **How many lifesaving jackets must be furnished?**
3. **With what are life rings equipped?**
3. **Where should the doughnut-type floats be stowed?**
4. **How many life nets and life ladders are required on a ship?**
5. **List the equipment of a life raft.**
6. **How many rubber lifesaving suits are provided?**
7. **What determines the number of lifeboats on a ship?**
8. **List the equipment for a lifeboat.**
9. **What size of falls are used on lifeboats?**
10. **Who places the lifeboats on deck?**
11. **List the equipment for a Lyle gun.**
12. **List the fire-fighting equipment that is placed on board by the riggers.**

[30]
CONDUCTING A TRIAL TRIP

General Information

When conducting a trial trip, the navigators, officers, quartermasters, and sailors, or the men of the entire deck department, are supplied by the rigging department.

When the management has checked with the hull and engine departments and found that the ship is or will be ready for trials, a letter is issued by the management stating the day, time, and approximate maneuvers that will be required during the trial of the ship in question.

These trials may vary from one-day river trips to extensive off-shore trials which may include a voyage to Rockland, Maine. The riggers are divided into captain and watch-officers, boatswain and quartermasters, sailors and a general utility man.

The rigging department also makes arrangements for river pilot, tugboats, radio operators, radio direction finder operators, and for any other needs that the trial trips may require.

The captain of the trial trip will arrange the watches to suit the particular needs of the trip. Among the equipment that the riggers are responsible for are: navigating, signal, fire-fighting, and lifesaving equipment; deck machinery; mooring lines and anchor chains; and code flags.

Duties of the Crew

1. The captain or master is responsible for the safe and proper conduct of the ship during her trials for the satisfaction of the builders and the future owners as specified and required by mutual agreement of the parties concerned.

2. The watch officers will stand watches as set by the master. These men are all licensed to perform the duties of the watches to which they are assigned, and are careful at all times to see that all proceedings and conduct on these watches are consistent with the best seafaring practices and with the rules for navigating and safeguarding lives and property as set forth by the Bureau of Marine Inspection and Navigation.

3. The quartermasters and lookouts on each watch are responsible to the watch officers, who are in turn responsible to the captain or master. The watch officers are responsible for steering the correct course, maintaining a proper lookout at all times, lighting and showing signal lights properly, and, in event of any special circumstance, notifying the master immediately. The watch officer should make certain at all times that the ship's anchors are ready for letting go if any danger should arise. The watch officers' stations when arriving in port or leaving port are as follows: Chief Mate on the fo'c'sle head, Second Mate on the after deck, and Third Mate on the bridge with the Captain.

4. The quartermaster's duties are to steer the ship in channels and on courses set by the master pilot or watch officers. In his orders, received from the master pilot or watch officers, he shall execute the order as given or the course as given, and notify the master pilot or watch officer when the ship does not answer the helm or when he cannot maintain the course required. The quartermaster's duties are primarily to steer the ship, but he also helps with anchoring, mooring, standing anchor watches, and any other work that may be required by his superiors, the master, pilots, watch officers, and boatswain. The watches stood by the quartermasters will be set by the master or deck officers.

5. The duties of the boatswain on the trials are to supervise the actual work of the sailors with regard to letting go lines, handling anchors, mooring, steering, securing any loose gear about the ship; to supervise any special circumstance that may arise and be delegated to him by the captain or the watch officers; and to perform any other duties that he knows are his responsibility. He pays particular attention to the anchors and chains and anchor windlass, and to fire-fighting and lifesaving equipment.

6. Seamen's or lookouts' duties are to relieve the quartermaster in the steering of the ship, to assist him in his other duties when the occasion requires, to maintain lookout watches when required by the watch officers, and to report any situation which they feel requires the attention of the captain pilot, or watch officers. While on watch they should look out particularly for discolored water, buoys, spars, wrecks, lights, light ships, or anything that may have a bearing on the ship's safety.

7. The utility man may be an apprentice in the hull department, engine department, or rigging department; his duties are to run errands and do other general utility work about the bridge for the captain, deck officers, or pilot during the various trials.

General Notes

All of the riggers who take part in a trial trip are chosen for duty because of past experience or particular ability. They all have Department of Commerce licenses and certificates for the positions they hold.

Trial trips usually include tests to prove the speed and maneuverability of the ship and the ability of the engines to produce a certain specified horsepower and shaft revolutions. Speed trials are usually conducted on a course where range lights and markers are available. Other tests conducted on the trip include those of the cargo pump equipment, general equipment, cargo handling gear, anchor handling gear, and steering gear.

Particular care should be taken by the deck department or riggers to see that the equipment for fire-fighting and lifesaving is in order and ready for use, that the signal lights are ready for use, and that the signal flags and other flags are ready and available.

List of Gear for Trial Trips—Deck Department

1. Lead lines and leads for gauging depth of water.
2. Fog-buoy reels, buoys, and lines for use in convoy duty.
3. Fog bell for use if anchored during foggy weather.
4. Fog horn for use if under way during fog when main whistle and siren are out of order.
5. Ring buoy, lights, and lines for use if a man falls overboard.
6. Anchor lights (electric and oil) for use if ship anchors at night.
7. Not-under-control red (ruby) lights for use when vessel cannot maneuver as required by the rules because of propulsion-engine or steering-gear trouble. Two black balls are used in daytime.
8. Fire axes, properly distributed.
9. Fire hoses, nozzles and spanners distributed, and hydrants checked and ready for use.
10. Fire extinguishers, distributed through the engine, fire and pump rooms and in the living quarters about the ship.
11. Pyrene fire extinguishers in radio room, battery room, and motor lifeboats.

12. Lifeboats and rafts properly equipped and ready for use.
13. Gas masks and all equipment for their use.
14. Storm oil in tanks and ready for use.
15. Flinder bars, magnets, compasses, and binnacle keys.
16. Azimuth mirrors and circles.
17. Log clock, rotator, line, and outrigger, ready for use.
18. International Code Flags and United States Ensigns (2 sets of each).
19. Heaving lines and stoppers of Manila rope.
20. Trial-trip box which should contain the following gear:
    a. Parallel rulers
    b. Dividers
    c. Whistles
    d. Flashlights, extra bulbs and batteries
    e. Pads
    f. Pencils
    g. Tide Table
    h. Current Table
    i. Light list
    j. Charts of areas to be navigated
    k. Megaphone
    l. Barometer
    m. Thermometer
    n. Azimuth Tables
    o. Nautical Almanac
    p. Logbook
    q. Signal Books
    r. Binoculars
    s. Speed Tables
    t. Wheelhouse Clock
21. Crew.
22. Food.
23. Water.
24. Fuel.
25. Pilot ladder.

Signals to Engine Room From Pilot House

(If Telegraph is Out of Order)

1. When engines are stopped, one bell means *Slow Ahead.*
2. When the ship is running slow ahead, jingling the bell means *Full Speed Ahead.*
3. When the ship is running full speed ahead, one bell means *Slow Down.*
4. When the ship is running slow speed ahead, one bell means to *Stop.*
5. When engines are stopped, two bells mean *Astern.*
6. When the ship is running astern, jingling the bell means *Full Speed Astern.*
7. When the ship is running astern, one bell means *Stop.*
8. When the ship is running slow ahead, three bells mean *Full Speed Astern.*
9. When the ship is running full speed ahead, four bells mean *Full Speed Astern.*

QUESTIONS

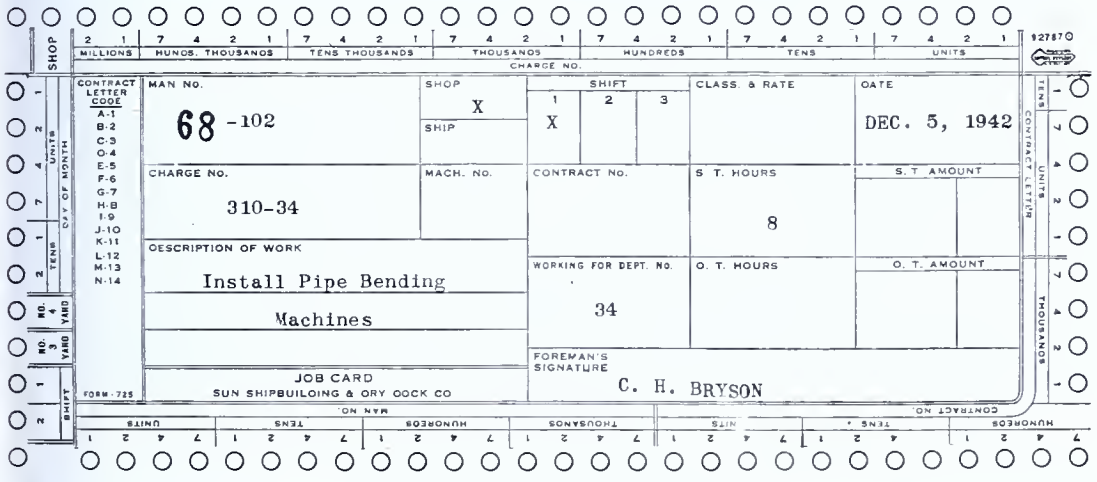
1. **What part does the rigger play in conducting a trial trip?**
2. **What qualifications must a rigger have to perform the duties of the watches on a trial trip?**
3. **What are the duties of the quartermaster on a trial trip?**
4. **What are the duties of the utility man?**
5. **What is the purpose of a trial trip?**
6. **What are the duties of the members of the deck department?**
7. **Name some deck equipment required by the crew on a trial run?**
8. **What are the signals for engine speeds when the telegraph is out of order?**

[31]
DAILY TIME DISTRIBUTION

Every job done by a man or gang of men under a leader is done for a department, on a number that indicates whether it was manufacturing expense, new hull building, an appropriation charge, a repair charge, or an outside sales charge.

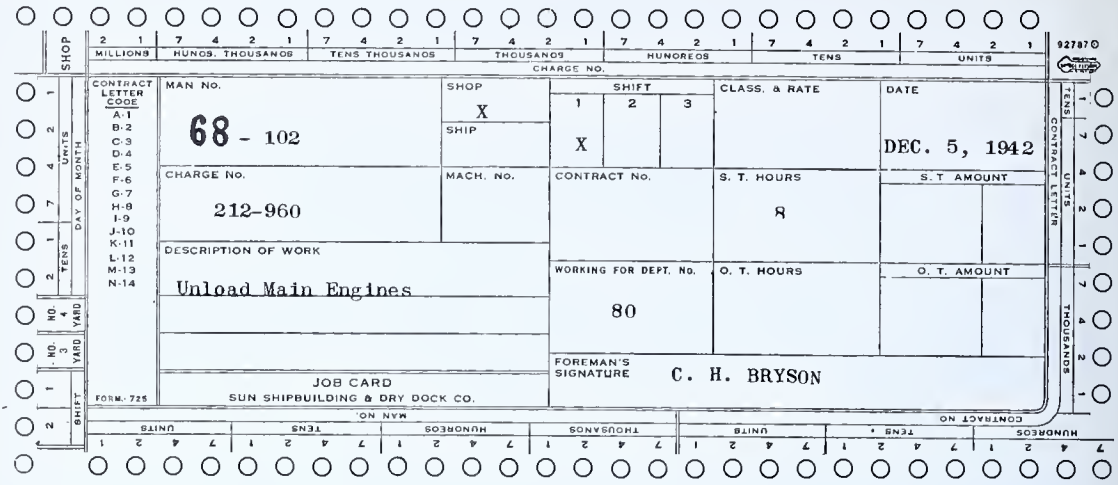
(1) Manufacturing expense charge numbers. These charges indicate the breakdown of the different kinds of expense in the yard and the department to which they are to be charged. Expense charges, such as listed below, are to be used only when there is no appropriation number, installation number, or repair work order number. See Example 1.

A complete list of the manufacturing expense accounts and their numbers



EXAMPLE 1

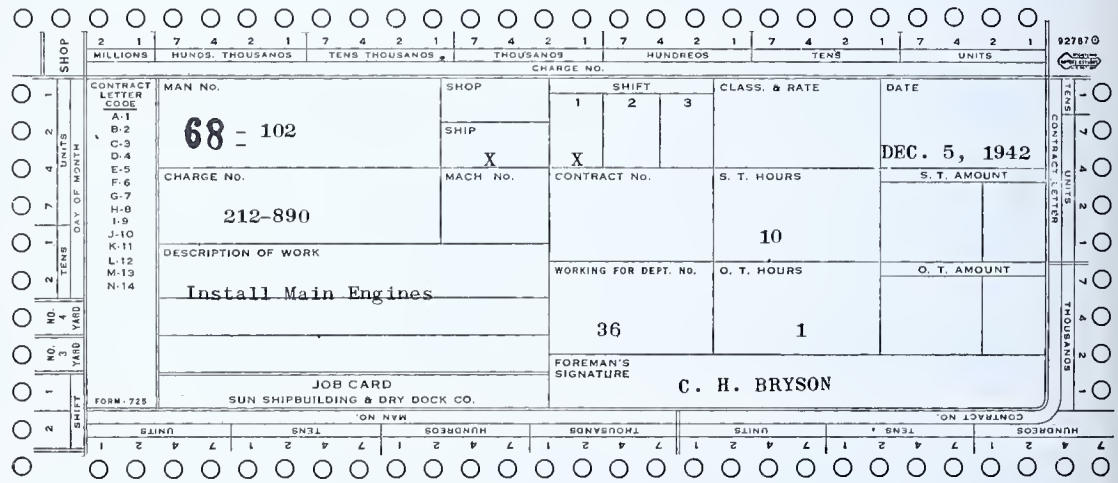
(2) If the job is done on a hull number and consists of unloading and storage, the cost is chargeable to the stores department and should be charged to (Hull Number) 212, (Job Number) 960 against 80 department as shown by Example 2.



EXAMPLE 2

(3) When equipment is installed on a ship, the ship number and the installation charge numbers are used. See example 3.

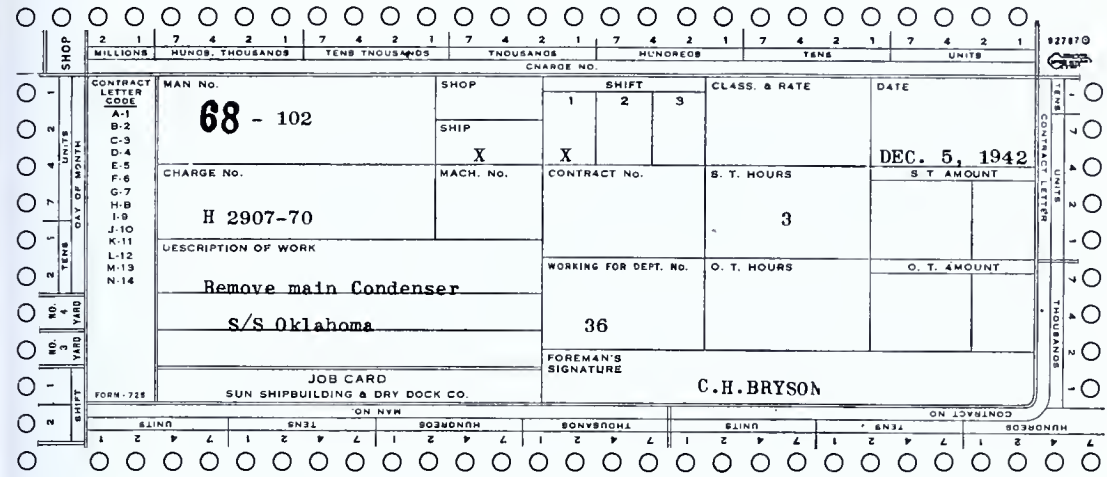
A complete list of manufacturing cost accounts and their numbers as used at the Sun Shipbuilding & Drydock Co. is shown on page 274.



EXAMPLE 3

(4) On repair work numbers 2000 to 2999 where a letter of the alphabet is used as a prefix, a work order is issued by the ship repair department on these main charges with small numbers for the separate items of repair such as: "S. S. Oklahoma, main charge H. 2907, item number 70, work to be done on main condenser," and should be recorded on the time distribution card as shown in Example 4.

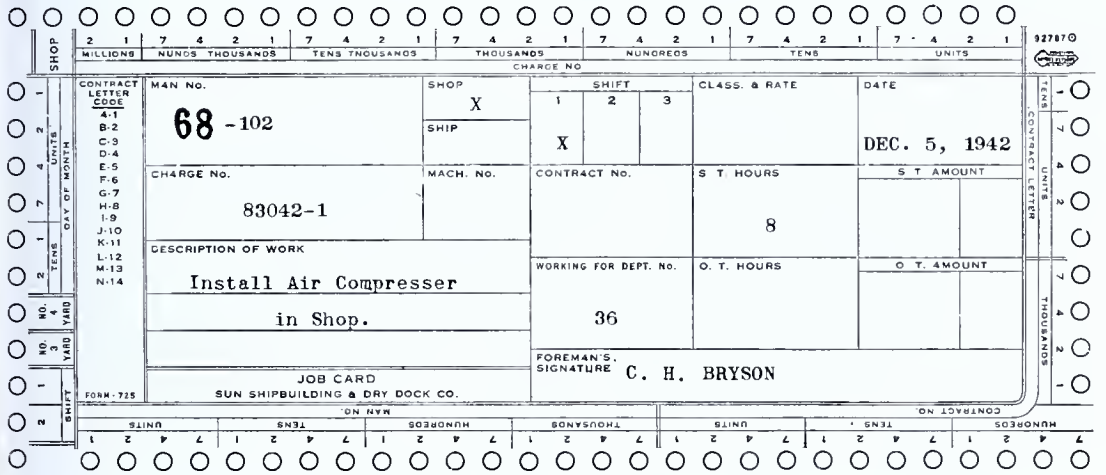
On all cases and on all jobs the best procedure for the proper allotment of costs is to specify the department for which the work was done.



EXAMPLE 4

(5) Appropriation charges are used when the company makes a special allotment of money to increase facilities, change the plant layout, or enlarge the plant.

The charge numbers for such work at the Sun Shipbuilding and Dry Dock Co. are from 80,000 to 84,999, inclusive. See Example 5.



EXAMPLE 5

There are other special charges, such as for work performed on outside sales. At the Sun Shipbuilding & Dry Dock Co., if the work originates with the Wetherill Plant, cost is covered by job numbers 3000 to 4999 inclusive, and if it originates with the shipyard, 5000 to 6999 inclusive — in each case prefixed by a letter of the alphabet.

Occasionally a rigger may be called upon to perform work which does not seem to be covered by one of the usual numbers. In such cases if the

person for whom you are doing the work cannot give you the job number, consult your foreman.

Charge Numbers

The charge numbers listed below are those used by the Sun Shipbuilding & Dry Dock Co. Although they are not the same as those used in other yards, they are given here as a typical example to enable riggers to familiarize themselves with the terms used and the classification of various kinds of work. Every rigger should learn the department numbers and names of the yard in which he is employed, as well as the charge numbers, in order to be able to fill out the necessary reports. For example:

Both material and labor for repairs to a damaged pier crane would be charged to 315 (Hoisting Machinery) and to 75 Dept. (Plate Yard and Material Handling), and the charge would read 315-75 Crane Repairs No. 2 Pier.

Department Numbers and Names

Dept.	*Name*	*Dept.*	*Name*
1	Pattern Shop	16	Stores
4	Foundry	17	Powerhouse
8	Machine Shop	19	General

Dry Docks

Dept.	*Name*
24	Dry Docks No. 1 and No. 2

Engineering Division

Dept.	*Name*	*Dept.*	*Name*
30	Boiler Shop	34	Pipe Shop
30-S	Sheet Metal Shop	34-C	Copper Shop
33	Electrical	36	Installation
33-D	Electrical Drafting	38	Engineering—Drafting

Hull Division

Dept.	*Name*	*Dept.*	*Name*
42	Blacksmith and Anglesmith	60	Burning
45	Fitting	65	Joiner
46	Lining, 6-20-41	66	Carpenter (Ship) and Stage Builder
47	Mold Loft	67	Cleaning
47	Laying Out and Fabricating	68	Rigging
51	Bolting—Drilling—Reaming	69	Painting, 9-1-41
55	Riveting and Chipping and Calking	74	Toolroom
58	Erecting and Regulating, 6-20-41	75	Plate Yard and Material Handling
59	Electric Welding	78	Scientific—Hull Detail
		79	Hull General

General Division

Dept. *Name*

80 — General Stores
81 — Yard General & Plant Guards
83 — Powerhouse
84 — Hull Machine Shop
85 — Commissary
86 — Hospital
88 — Guards, 9-1-41
90 — Financial—General Accounting
90 — Timekeeping
90 — Service
90 — Purchasing—Traffic
90 — Order
90 — Employment
90 — Administrative
95 — Heating Plant

Sales

Dept. *Name*

96 — Sales

Manufacturing Expense

Maintenance and Repairs

300 — Ground and Fences
301 — Buildings
302 — Water System and Other Systems of General Use
303 —
304 —
305 — Docks, Piers, and Bulkheads
307 —
308 — Heating and Ventilating System
309 —
310 — Machinery and Appliances
311 — Safety Appliances
312 — Fire Protection Apparatus
313 — Line Shafting, Pulleys and Transmission Equipment
314 — Belting
315 — Conveyors, Hoisting Machinery and Appliances
316 —
317 — Electric Wiring and Apparatus
318 — Motors
319 —
320 — Furnaces, Forges and Ovens
321 — Blocking, Staging and Shoring
322 — Yard Railways and Locomotive Cranes
323 — Miscellaneous Shop and Yard Equipment
324 — Maintenance of S/S Co. Freight Cars
325 — Steam Boilers
326 — Power Plant Equipment
327 —
328 —
330 — Clock and Telephone Equipment
331 — Shop Furniture and Fixtures
332 — Office Furniture, Fixtures and Appliances
338 — Loose and Hand Tools, Repairs
339 — Loose and Hand Tools, New Tools
340 — Special Tools
341 — Patterns and Forms
342 — Drawings and Blueprints
345 — Tugs and Service Boats
346 — Auto Trucks and Auto Cars
348 —

Wages and Salaries

353 — Clerks and Stenographers
354 —
355 — Department Foremen and Assistants
356 — Inspectors
357 —
358 — Oilers and Belt Repair Men
359 — Cleaners and Sweepers
360 — Truckers and Men Handling Material
361 — Service Boat Crews
362 — Truck and Wagon Drivers
363 — Watchmen, Janitors, and Messengers
364 — Elevator and Crane Men
365 — Engine and Boiler Attendants
366 — Shoveling Snow and Other Labor Due to Storm
367 —
368 — Pickling and Oiling Plates and Shapes
369 — First-aid Attendants, including Doctors
370 — Stores Department
371 —
372 — Tool Crib Attendants
373 — Stock Chasers
374 —
375 — Purchasing Department
376 —
377 — Dock Hands (Dry Dock)
378 —
379 — Estimating Expense: "Order Not Received"
380 — Factory Timekeepers and Production Clerks in Shop
381 — Pay Roll and Cost Departments
382 — Financial and General Bookkeeping Departments
383 —
384 —
387 — Commissary Attendants
388 — Miscellaneous Productive Labor
389 — Miscellaneous Nonproductive Labor

Traveling and Entertainment

390 — General Manager, Supts., and Asst. Supts.
392 — Chief Engineer and Assistants
396 — Foremen and Assistants
397 — Other Office
398 — Other Factory

Supplies

400 — Fuel
402 — Waste
403 — Lubricants
407 — General
409 — Tugs and Service Boats
410 — Auto Truck and Cars
411 —
412 —
413 — Commissary Supplies

Allowances, Losses, Errors and Defects

420 — Defective Workmanship
421 — Defective Material
422 — Defective Material—Bought Outside
423 — Defective Design or Purchased in Error
424 — Accident to Product
425 — Disassembling and Reassembling.
426 — Lost Material
427 — Lost Time, waiting on Layout or Material

428 — Lost Time, waiting on Orders or Instructions
429 — Lost Time, waiting on Tools
430 — Lost Time, waiting on Service (Cranes, etc.)
431 — Lost Time, Machinery or Power Breakdowns
432 — Sick, Injured, and Absent
433 — Holidays paid for by Company
434 — Welfare Expenses
435 — Overtime excess wages paid
436 — Transportation and Lunches of Employees
437 — Factory Guarantee
438 — Wage Allowance for Night Work
439 — Demurrage and Track Storage

Miscellaneous

440 — Stationary and Office Supplies
441 — Postage
442 — Telephone and Telegraph
443 — Advertising other than Sales
444 —
445 — Taking Inventory
446 — Miscellaneous Experimental
447 — Rearrangement of Equipment
448 — Development Engineering
449 — Freight and Express Unapplied
450 — Outside Drayage
458 — Unusual Expenses

Purchased Power, Gas and Water

460 — Electric Light Power
461 —
462 — Gas
463 — Water

Fixed Charges

470 — Fire Insurance
471 — Liability Insurance
472 — Employees' Sick Insurance
473 — Fidelity Insurance
474 —
475 — Taxes—Property
476 — Taxes—Capital Stock
477 — Taxes—U. S. Employers
478 — Taxes—Federal Old Age Benefits

Division of Manufacturing Costs

Prefixed to every manufacturing cost charge is the number of the hull for which or on which the work is performed.

Let us assume the Hull Number is 230, which becomes the S/S Atlantic States, and the job is installing main engine, which is number 890, for 36 Department, the machinists.

The charge, according to the card of accounts, would be written 230-890. Install main engines — 36 Dept.

Numbers of the manufacturing cost charges used at the Sun Shipbuilding and Dry Dock Co. are as follows:

Hull

700 — Engineering and Drawings—Light-Draft Inclining
701 — Mold Loft Work
702 — Staging and Blocking, etc.
703 — Heavy Forgings and Castings—Rudder
704 — Structural Hull
724 — Steel Hatches, Doors
725 — Air Ports and Deck Lights
726 — Metal Skylights
744 — Masts, Booms, Rigging, etc. testing same
752 — Joinery—accommodation ladder
755 — Metal Inside Sheathing
756 — Metal Bulkheads
760 — Calked Wood Decks, etc.
778 — Hull Natural Ventilation
779 — Hull Mechanical Ventilation
780 — Scuppers
783 — Warping, Mooring and Towing Gear
785 — Anchor Gear, Anchors and Spares for chain
790 — Boats and Boat Davits and Stowage
791 — Hotel and Galley Outfit
792 — Handrails, Stanchions and Ladders
793 — Metal Ladders
794 — Miscellaneous Inside and Outside Riggings including deck outfit (fire hose) (binnacles)
795 — Painting and Varnishing
796 — Elevators
797 — Deck Covering including Cementing
798 — Canvas Sails, Awnings and Covers
799 — Scrap

Engineering

800 — Engineering and Drawings
806 — Main Propulsion Engines, Steam or Diesel, including Electric Propulsion, etc.
807 — Engine Bed Plates
808 — Engine Cylinders
809 — Engine Housings
810 — Engine Receiver Pipes
811 — Engine Condensers
812 — Engine Column Bridge (Oil Eng.)
813 — Engine Piston Rods and Crossheads
814 — Engine Crankshaft
815 — Engine Exhaust Belt and Silencer (Oil Eng.)
816 — Engine Valves and Valve Gear
817 — Engine Throttle Valve and Handling Gears
818 — Scavenger Pump, Complete
819 — Engine Turning and Reversing Gear
820 — Engine Oil and Water Service
822 — Engine-attached Pumps
823 — Main-engine Covering Lagging
824 — Engine Assembling in Shop. Also Disassembling
825 — Boxing, Crating and Shipping
826 — Engine Repairs and Renewals. After Delivery
830 — Turbine and Reduction Gear
839 —
840 — Propeller (Not Installation). See 892

842 — Shafting and Bearings (Not Installation). See 892
844 — Floors, Ladders and Gratings
853 — Dredging Pump
854 — Auxiliary Machinery
855 — Refrigerating Plant
856 — Miscellaneous Fittings, Spare Wheel Shaft Armatures
858 — Deck Auxiliaries and Installation
862 — Main Boilers, Scotch
863 — Main Boilers, Watertube
864 — Boiler Lagging
865 — Main Boiler, Fittings
866 — Main Boiler, Furnace Fittings
867 — Main Boiler, Gas fired
869 — Fuel Oil System
880 — Smokestacks and Uptakes, etc.
882 — Forced Draft System
884 — Fire Room Fittings
890 — Installation of Main Propulsion Engines on Ship, Diesel or Steam, including Electrical Propulsion
892 — Installation of Line and Thrust Shafting and Propeller
893 — Installation of Auxiliary Machinery in Engine Room and Fire Room
894 — Installation of Boilers
898 — Scrap
900 — Piping, Steam and Exhaust, including Lagging, Piping Valves, Fittings and Flanges
901 — Water Piping, Valves and Fittings in Engine-room and Fireroom Spaces
902 — Air Starting System
903 — Engine Fuel Oil System
904 — Lubricating Oil System
905 — Circulating Water System
914 — Heating System
915 — Engine and Boiler Room, Natural Ventilation
916 —
918 — Hull Piping, Drainage and Plumbing
919 —
920 — Fire Protection System
923 — Liquid Cargo System
940 — Electric Generator and Switchboard and Lighting, Except Diesel Electric Propulsion and Control Equipment
941 — Auxiliary Power
942 — Interior Communications

General

950 — Setting Up and Launching
958 — Cleaning and Caretaking—mooring ship
959 — Temporary Lighting, Air and Water Service
960 — Miscellaneous General Expense, not Chargeable to a Particular Job No. (Loading and unloading material for a particular hull up to a point where installation begins.)
962 — Trial and Delivery
964 — Repairs and Delivery
965 — Drydocking
990 — X-Raying
995 — Stress Relieving

GLOSSARY
SHIPYARD RIGGING TERMS AND DEFINITIONS

A

A Frame — A steel frame built in the shape of a saw horse, used for supporting a load during the process of lifting.

Abaft — Aft of; farther aft than.

Aft — Toward, at, or near stern.

After — Nearer stern.

Aftermost — Nearest the stern.

Amidships — At or near the midship section of the ship.

Ammunition Chamber — A locker for ammunition in the vicinity of the guns or gun emplacements.

Anchor — A heavy, hook-shaped device for holding a ship at rest in water. The anchor grips the ocean (or river) bottom and is fastened to the ship by a chain.

Anneal — To soften metal by heating and allowing it to cool slowly. When cast iron is annealed, the carbon is burned out near the surface. Without carbon the outer surface is tough and strong; the interior remains hard.

Aperture — The space provided for the propeller. It is the space between the propeller post and the sternpost.

Azimuth Circle — A graded ring attached to a compass and fitted with vanes, screws, and other apparatus.

B

Barge — A craft of full body and heavy construction, designed for the carriage of cargo, but having no machinery for self propulsion.

Basin — A natural or artificial berthing place in which ships may float safely at any stage of the tide.

Battens — Wooden protective strips in cargo holds.

Batten Boards — Long strips of wood in the mold loft for fairing lines.

Beam Clamp — A device for attaching to the lower flange of a deck beam; it is used for hooking on a purchase, lead block, etc. It is made of metal in two parts, one of which has a sharp bend and hooks over the flange; the other, a straight flat piece, fits against the back of the web of the beam. The two parts bolt together securely. In the lower end is a worked eye extending through both parts. A ring is usually fitted into the eye.

Becket — A small grommet used for various purposes, as for reefing a sail with toggles; the extension of the check straps of a block together with the bolt and thimble or eyebolt to which is secured the standing part of the fall.

Below — Below a deck or decks (corresponding to "downstairs").

Bend — The act of securing one thing to another; as, an anchor to a cable; a sail to a yard; one line to another, or to a buoy, boat, etc.

Bending Shackle — The heavy shackle which connects the chain cable to the ring or shackle attached to the shank of an anchor.

Berth — A place for a ship; a place to sleep; a bunk; also, a specified small section of the hull structure.

Bight — (of rope) A loop or bend in a rope; though, strictly considered, any part between the two ends may be termed the bight.

Bind — To secure the end of a rope against unlaying by taking turns of twine or small stuff around it. The term is synonymous with whip.

BINNACLE — A stand or case for housing a compass so that it may be conveniently consulted by a helmsman or navigator.

BITT — A vertical post used in making lines fast; a bollard.

BITTER END — The extreme inboard end of a chain cable; this end of the cable is secured in the locker.

BLACK BALLS — Two black balls or shapes, each two feet in diameter, used to signal to other boats that the vessel showing them is not under command.

BLOCK — A device used in applying power to move heavy weights by means of tension in a cable. It consists of a frame made of wood or metal containing one or more pulleys or sheaves, set side by side and turning on the same axis.

BLOCKS, CARGO — Blocks with wide swallows and sheaves with curved lips and steel, iron, or lignum vitae shell pieces. They are generally fitted at the boom end and used as lead blocks under the gooseneck.

BLOCK, SNATCH — A single block with a hook or bail. This block has one end of the frame arranged so that it can be hinged up to allow the bight of a rope to be placed on the sheave. Use of the snatch block eliminates passing one end of the rope through the swallow.

BLOCK STOPPER — A short piece of rope attached to a stationary block, used to secure the running part of a fall temporarily.

BLOCK, SWIVEL — A block having a swivel attached to its supporting hook or shackle, thus allowing it to revolve.

BLOCK, GIN — A single block with a metal frame having a sheave of large diameter for ease in overhauling; used where the operation of hauling by a single part is to be performed many times in succession in hoisting cargo.

BOAT HOOK — A metal fitting in the form of one or more hooks or a prong attached to the end of a pole. Boat hooks are used for catching, holding, and steadying small boats.

BOAT STOWAGE — The provisions made aboard a ship for stowing and launching lifeboats.

BOATSWAIN (Bo's'n) — One of the lower officers on shipboard who has immediate charge of the deck force, deck gear, boats, rigging, cordage, etc.

BOATSWAIN'S CHAIR — A piece of plank hung in two straps and forming a seat on which a man may be hoisted aloft or lowered over the ship's side.

BOILER — Container in which water is heated to form steam.

BOILER FUNNEL — See smokestack.

BOILERMAKERS — Workmen engaged in the construction and erection of the component parts of boilers, condensers, and uptakes.

BOLT, EYE — A rod of metal with one end having the shape of a doughnut, and the other end having a screw thread cut on it or left smooth for riveting over.

BOOM — A long, round, heavy spar, pivoted at one end, generally used for handling cargo, etc.

BOOM REST — A support for a boom when the boom is not in use.

BOOM STEP — A socket for the end of the boom.

BOSS — The curved, swelling portion of the ship's hull around the propeller shaft.

BOSS FRAME — A hull frame which is bent for clearing propeller shaft tube.

BOTTLE TURNBUCKLE — A turnbuckle which has a pipe covering over the threads. It is filled with white lead and tallow to keep out water and prevent corrosion.

BOW — The forward end of a ship.

C

CAPSTAN — A revolving drum, with vertical axis, used for heaving in lines.

CAPSTAN BAR — A hard wood or steel bar used to turn a capstan.

CARGO — The freight carried by a ship.

CARGO BOOM — A heavy boom used in handling cargo.

CAST STEEL — Steel melted, cast into ingots, and rolled into bars.

CHAFING PLATE — A bent plate used in minimizing chafing of ropes, as at hatches.

CHAIN, CLOSE-LINK — Chain in which the links are so short in relation to their width that studs cannot be fitted.

CHAIN HOIST — An arrangement of chains, gears, sheaves, and hooks in the form of a fall, used for raising, lowering, or handling heavy weights in the shop or aboard ship.

CHAIN LOCKER — A space or room in which the anchor chain is stored.

CHAIN, STUD-LINK — Chain in which each link has a short piece or stud worked at its mid-length at right angles with its major axis.

CHAIN STOPPER — A device used to secure the chain cable when the ship is riding at anchor, thereby relieving the strain on the windlass. It is also used to secure the anchor in the housing position in the hawse pipe. The chain stopper may be of hemp or wire rope or chain.

CHOCK — A heavy fitting through which ropes or hawsers may be held. A saddle or seat of wood or metal.

CHOCK, BOAT — A cradle or support for a lifeboat.

CHOCK, ROLLER — A roller with a sheave to prevent chafing of ropes.

CHOKER — A pendant.

CIRCUMFERENCE — The bounding line of a circle.

CLAMP — A metal fitting used to grip and hold wire ropes; used in lieu of a short splice or eye splice.

CLEAT — A fitting having two arms, or horns, around which ropes may be made fast. A clip on the frames of a ship used to hold cargo battens in place.

COIL — Rings of cable, rope, and the like, when coiled; also a single ring of rope or cable.

CONTLINE (of a rope) — The sunken space, or groove, following the lay of the rope between the strands.

CORD — A small rope. Cords collectively; the ropes used in the rigging of a ship. Two or three yarns twisted together, additional twist being put in the yarns during the process in an opposite direction to the turn in the cord.

CORNER MACHINE — A mechanism for applying air power to a gear wheel or chain hoist for reeling wires on a hawser reel or for pulling a tail shaft in or out of a stern tube.

CRANE — A machine used for hoisting and moving pieces of material or portions of structures or machines that are too heavy to be handled by hand or that are heavy enough to make handling by hand uneconomical.

CRANE, BRIDGE — An overhead type of crane usually installed in shop buildings. This type generally consists of one or more girders mounted on trucks with wheels which run along tracks supported by columns of the building. A trolley travels across the beam for lateral motion.

CRANE, GANTRY — An elevated structure designed to travel along rails on the ground level and provided with a hoisting gear, or an extended beam.

CRANE, JIB — A boom or arm fitted to swing in sockets attached to a wall or column. The boom is generally fixed in a vertical direction but free to move horizontally.

CRANE, LOCOMOTIVE — A self-propelling car with a crane mounted on it.

CRANEMEN — Men who operate overhead, gantry, or other cranes in the yard or shop.

CRANE, PILLAR — A swinging boom or arm supported by a pillar or post. Usually no vertical motion is provided for in this type of crane.

CRANE SIGNALS — Signals made by motions of the hands to inform the craneman which way to move the load being lifted.

CRANE WIRE — Wire rope used on cranes. It is especially suited to withstand excessive abrasion and possesses a high reserve strength.

CRINGLES — Iron thimbles or grommets worked into the edge, head leach, or clew of a sail for making fast the bowline, bridles, ear rings, sheets, etc.

CROWN — A knot formed by bending the strands of a rope over each other and tucking the ends.

CUTTER, CAREW — A type of wire-cutting nippers.

CUTTER, HYDRAULIC WIRE — A cutter for cutting heavy wire rope by the use of hydraulic pressure.

D

DAVIT — A crane used to lower and raise lifeboats. Sometimes it is used in handling anchors, oil hoses, or ships stores.

DECK — A part of a ship corresponding to the floor of a building.

DECLIVITY — Inclination of shipways to provide for launching.

DERRICK — A device for hoisting heavy weights, cargo, etc.

DIAMETER — The length of a straight line from circumference to circumference through the center of a circle.

DOLLY BAR — A heavy bar held against a rivet to give backing while the other end is being riveted.

DRAFT — The depth of a ship in the water measured in feet and inches above the keel. It is marked on the ship at the bow, amidships, and at the stern.

DRUM — A hollow spool for holding wire rope.

E

ENSIGN — A flag indicating a vessel's na tionality. It is hoisted at the stern whe the ship is anchored or moored. Whe the ship is under way the ensign is a the aft (main or mizzenmast) gaff.

ERECTOR — A man who works on puttin together the hull of the ship.

EXPEDITER — A man with some know edge of rigging who makes advanc checks of equipment in order to mak sure that the gear will be availabl when needed.

EXTENSION BAR — A heavy bar about 36 long with a threaded end (and nut which is bolted to the flanged end o a tail shaft. The bar extends out an is hooked into a chain-hoist hook an used to haul the tail shaft out whe there is not sufficient space for the reg ular hauling gear.

EYEBOLT — A bolt, the head of whic is in the form of a ring or eye.

F

FABRICATE — To make raw material read for assembly or erection.

FATHOM — Six feet.

FENDER — A portable device to protect ship when it bumps against a pie sometimes made of wood, rope, etc permanently installed extension whi protects the hull of a ship while it being docked and while it is in dock.

FID — A pointed wooden spike, larg than a marline spike.

FORE-AND-AFT — In line with the leng of the ship, longitudinally.

FORE-AND-AFT GANGWAY — A walkw between deckhouses at or near the c ter line of a ship.

FORECASTLE — The forward, upper p tion of the hull, sometimes used for crew's quarters.

FORWARD — Near, at, or toward the of the ship.

FUNNEL — A smokestack ot a vessel.

G

GALVANIZING — Coating metal parts with zinc for protection from rust.

GANGWAY — A passageway, a ladder, or other means of boarding a ship.

GANTLINE — A long rope led through a single block aloft on a mast, smokestack, or boom lead to the deck for hauling a man, tools, or other gear up on the mast, stack, or boom.

GAUGE, GROOVE — A gauge for measuring sheave grooves.

GEAR — A comprehensive term in general use on shipboard signifying the total of all implements, apparatus, mechanism, or machinery, pertaining to or employed in the performance of any given operation.

GIN BLOCK — See Blocks.

GIN POLE — A pole of wood or tubing to which is attached a series of tackles used to lift and place loads.

GOOSENECK — The usual fitting at the heel of a cargo or other boom.

GRANNY KNOT — See Knots.

GRIPE, BOAT — An arrangement for holding a small boat securely in its stowage chocks.

GROMMET — A soft ring used under a nut or bolthead to maintain watertightness. In canvas work, the grommet is a brass eyelet.

GROOVE, SHEAVE — The part of a sheave over which the rope rides.

GROUND WAYS — Timbers secured to the ground under the hull on each side of the keel. These timbers provide an inclined plane from which a ship is launched.

GUN, LIFESAVING OR LYLE — A small cannon which shoots a projectile with a small shot rope attached.

GUNWALE — A term applied to the line where an upper deck stringer intersects the shell.

GUYS — Wire or hemp ropes or chains to support booms, davits, etc., laterally. They may consist of single lines or purchases, leading from the davit head or boom end to the deck.

GUY ROPE — A wire rope with a wire center, a steadying rope.

GYPSY — A small auxiliary drum usually fitted on one or both ends of a winch or windlass.

H

HAMBROLINE — A cord of three yarns having the opposite twist from roundline. (Yarns are spun left-handed.)

HANDSPIKE — A round bar, or lever, of hard wood which is placed horizontally in the head of a capstan. It is used to apply power in turning the capstan. A tapered steel bar for small splicing and for shackling and unshackling.

HANDY-BILLY — A small tackle for use about the deck.

HATCH — An opening in a deck for passage of cargo, etc.

HATCH BATTENS — Flat bars which are wedged against hatch coamings to secure tarpaulins.

HAULAGE ROPES — Wire ropes of six strands, seven wires to the strand, and one hemp core.

HAULING PART — The moving and pulling part of a tackle.

HAWSER-LAID (rope) — A rope, the lay of which is left-hand and made up of other ropes instead of strands.

HAWSE PIPE — A casting, or castings, through the deck and the side of a ship at the bow for the passing of the anchor chain. The anchors are secured there.

HAWSER — A large rope used in towing or mooring; either manila or wire rope.

HEAVE — To haul; to cast or hurl; to heave the lead; to heave a line.

HEAVING LINE — A length of Manila rope (about 100 feet) in 6-, 9-, 12-, 15-, or 18-thread, one end weighted with a monkey fist. It is used to heave across an intervening space, as from ship to shore or vice versa.

HELIX — A constant-pitched curve around a cylinder.

HEMP — A fiber of which certain ropes are made.

HITCH — A term applied to a variety of methods of bending a line to a post, spar, or ring so that it can be readily detached.

HOIST — An apparatus for raising loads.

HOOK — A bent piece of iron or other metal used for catching.

HOME — Close up; snugly in place.

HOSE — A term applied to more or less flexible tubing used to convey water, oil, compressed air, etc.

HOSE NOZZLE — A tapered pipe having a screw thread cut on the large end for attachment to the end of a hose line.

HOUSELINE — A marline cord having three yarns, which are spun right-handed.

HULL — The body of a ship, including shell plating, framing, decks, and bulkheads.

HUNDREDWEIGHT — 112 pounds.

I

I BEAM — A structural shape with cross section resembling the letter I.

J

JACK — A short name for any one of the several types of jacks used for raising or jacking up a load.

JACK, HYDRAULIC — A machine for raising or moving heavy weights; the power is exerted by means of the pressure of some liquid acting against a piston or plunger.

JAW — The "jaw" is the distance between two points on the same strand, and measures along the rope in a direct line.

K

KEEL — The principal fore-and-aft member of a ship's frame. The keel runs along the bottom, connects the stem and stern, and serves as an anchor for the frames which are attached to it.

KEEL BLOCKS — The heavy blocks which support the keel of the ship during construction or dry-docking.

KING POST — A stub mast, outboard from center line, used to carry cargo booms; king posts often serve as ventilators.

KNOT — A tie in a line. A nautical mile, 6080 feet. Statute mile is 5280 feet.

KNOT, GRANNY — A knot in which the first crossing is reversed from that in a square knot. This knot is insecure, difficult to open when jammed, and held in contempt by seamen.

KNOT, MATTHEW WALKER — A single and a double knot named for the originator. It is made by hitching each of the three strands in the direction of the lay in such a manner that the rope can be laid up and continued beyond the knot. The knot is in the form of a transverse collar around the rope and is used on the end of deadeye lanyards.

KNOT, SQUARE — A knot in which the ends protrude on the small side of the loop as the standing parts. It is sometimes called a "flat knot", and it is frequently known, too, as a "reef knot" because of its use in tying reef points. This knot will not slip, but it does not answer well for uniting ropes of very different sizes, since the parts will slip unless stopped down.

L

LASHING — A Manila or wire-rope lashing is a piece of rope used to bind or secure something.

LASHING RING — A steel ring, generally of drop-forged steel, used to handle loads that must be transferred from crane to chain hoist or from chain hoist to chain hoist.

LAUNCHING — The operation of placing a hull in the water by allowing it to slide down on greased skids called launching ways.

LAY (OF ROPE) — A term used to designate the amount of twist put into a rope; i.e., the angle of the strands in the rope and the angle of the threads in the strands. The term is used also to designate the direction of rotation of strands, right or left.

LAUNCHING GREASE — A lubricant applied to the sliding ways and the ground ways in launching a vessel.

LAUNCHING TALLOW — Tallow used as a lubricant for the sliding ways and the ground ways when a vessel is launched.

LAZY GUY — A name given to a light rope or tackle used to prevent a boom's swinging around.

LEAD — The manner in which a line or rope is passed through, around, or over a block sheave, fair lead, chock, or mooring post to maneuver a load or a ship to a desired position.

LEAD LINE — A fine line marked off in fathoms or feet, weighted at one end with a sounding lead, and used for measuring the depth of water.

LEFT-LAID ROPE — Rope in which the strands are twisted to the left as the observer looks along a length of the rope.

LENGTH OVER ALL — The length of a ship measured from the extreme forward end to the aftermost point of the stern.

LIFE-BUOY RING — A ring made of solid cork or equally buoyant material having an outside diameter of not less than 30″ and an inside diameter of not less than 17″.

LIFE RAFT — A framework enclosing two or more air cylinders to provide sufficient buoyancy to support a designated number of people.

LIFEBOAT — A small boat carried on davits or on one of the upper decks of a vessel where it can be easily lowered into the water in case of an emergency.

LIFTING PAD — A piece of metal with a hole in it. It is usually welded to a member to provide a means of lifting.

LIGNUM VITAE — A wood of very hard and oily nature. It is used in strips or blocks as a bearing surface for the propeller shaft in the stern tube.

LINE — A general term for a rope of any size used for various purposes.

LINK, DETACHABLE — A patented link that can be taken apart. It is used for attaching chain to fittings, to other pieces of chains, or to an anchor.

LIST — To lean over to one side.

LOG — An apparatus for ascertaining either the momentary speed of a vessel in knots or the distance she has traveled in a given time.

LOGBOOK — A book in which the records of a voyage and remarks relating thereto are recorded.

LOG LINE — The line connecting a log chip or harpoon log to the vessel, or the line between the rotator and the registering mechanism of a taffrail log.

LONG TON — 2240 lbs.

LUFF TACKLE — A purchase consisting of a length of rope, a fixed double block, and a movable single block.

LUG PAD — A deck projection with a hole in it for fastening a block for a lead.

M

MAIN DECK — Usually the deck immediately below the shelter, or weather, deck.

MANILA — The prepared fiber obtained from the stalk of the wild banana.

MARLINE — A tarred, hemp, two-stranded, left-handed small stuff, about ⅛ inch in diameter, used for neat seizings and fine service.

MARLINE-CLAD WIRE ROPE — Durable wire rope in which each strand is served with tarred marline before being twisted about the core (5 strands of 19 wires each).

MARLINE HITCH — A half hitch in which the hauling part comes out underneath the standing part.

MARLINE SPIKE — A pointed, tapering tool which is used in separating strands of rope or cable in splicing.

MARLING — To hitch marline, spun yarn, etc., around the parceling on a rope to keep it in place while the serving is done.

MAST — A long, heavy spar, placed nearly vertical on the center line of a ship. In order the masts on a ship are: foremast, mainmast, mizzenmast, jigger mast, driver mast, and spanker mast.

MAINMAST — The principal mast in a vessel, located 2nd from forward.

MAST, STEP — A term applied to the foundation on which a mast is erected.

MATTHEW WALKER KNOT — See Knots.

MESSENGER — A Manila-rope messenger is a long length of 100 to 150 feet of Manila rope made fast to the hauling part of another rope or tackle lead through a snatch block to a winch to facilitate hauling or lifting a load. It may also be of wire rope.

MESSENGER CHAIN — A term applied to a chain used in transmitting power from one machine to another.

MESSENGER WHEELS — A term applied to wheels that are fitted to two machines for the purpose of allowing one machine to drive the other by means of a messenger chain or rope.

METAL, ZINC — A metal of bluish-white color that tarnishes and whitens slightly when exposed to the air. Used for securing wire-rope sockets and wire.

MIDSHIP — At or near the middle point of the length of a ship.

MIDSHIP SECTION —A vertical cross section through the ship, midway between the forward and after perpendiculars.

MOORING — Securing a ship in position by several lines or cables so that it cannot move or swing; anchoring.

MOORING LINE — Any rope 5 inches or more in circumference is called a hawser and is used to moor, haul, or tow a ship.

MOORING PIPE — A casting which prevents chafing of mooring lines that pass through bulwark plating. Sometimes called a bull's-eye.

MOUSE A HOOK — To pass several turns of wire or small stuff around the point and back of a hook to prevent its unhooking in lowering.

MOUSING — The small stuff or wire used to mouse a hook.

N

NIGGERHEAD — A small auxiliary drum usually fitted on one or both ends of a winch.

O

ON BOARD — On or in the ship.

ON DECK — On the upper deck; in the open air.

OVERBOARD — Outside; over the side of a ship; into the water.

P

PACKING — Material which is placed between plates or shapes to make them watertight; wooden blocks and wedges which support a ship on the sliding ways; spacers.

PACKING WIRE — A wire used to hold the wood launch packing in place against the side of the ship.

PAD EYE — An eye located on deck for fastening cables; on the hull, an attachment for hanging a block and fall for lifting propeller or rudder.

PALM — Flattened top portion of rudder (for bolted connection to the rudder stock); also, a flat surface at the end of a strut or stanchion; also, a sailor's tool used in sewing canvas.

PALM WHIPPING — A short length of seizing at the end of a rope to prevent it unlaying.

PARCELING — Narrow widths of canvas which when tarred are wound around ropes.

PELICAN HOOK — A type of quick-releasing hook used at the lower end of shrouds, on boat gripes, etc.

PENDANT — A length of rope usually having a thimble spliced into the lower end for hooking to a tackle. When it is suspended from a masthead, yard, or gaff, it is known as a masthead pendant, brace pendant, etc.

PINTLES — The pins on which a rudder hinges.

POLLY CLAMP — A piece of metal shaped like a poll parrot's jaws and used for making a chain hoist fast when transferring a load from one place to another. With care it can be used on loads up to 2 tons.

PORT — A harbor; an opening in the side of a ship; the left-hand side of a ship (as the observer looks toward the bow from aft).

PROFILE — A side elevation of a ship's form.

PROPELLER — A rotating device which drives a ship through the water.

PROPELLER APERTURE — See Aperture.

PROPELLER POST — The forward post of the stern frame, which is bored for the propeller shaft.

PROPELLER SHAFT — Rotating bar by means of which the engine turns the propeller.

PURCHASE — Any mechanical advantage which increases the power applied.

Q

QUARTERMASTER — A petty officer of a ship's crew who attends to the helm, binnacle, and navigating instruments.

R

RACKING — Spun yarn or other small stuff used to bind two ropes together.

RADIUS — The distance from the center of a circle to the circumference.

RAKE — The aft slope of a mast, king post, or stack.

RATLINE STUFF — A right-handed, three-stranded small stuff, usually four to eight threads to the strand, making 12-thread, 15-thread, etc., ratline stuff.

REEL — A wood or metal cylinder used for carrying, storing, or hauling wire or Manila rope.

REEVING — The act of passing a rope or chain through an aperture, as a rope through a block, deadeye, bull's-eye, etc., or a lacing through an eyelet.

RIGGING — Ropes, wire ropes, lashings, masts, booms, etc.; also, the handling and placing of heavy weights and machinery.

RIGGING SCREWS — Implements possessing the mechanical advantage of the screw. They are used at the lower ends of shrouds and stays in lieu of deadeyes and lanyards. They are more frequently called turnbuckles.

RIGGING, STEEL WIRE — The standing rigging practically in its entirety, as well as a large part of the running rigging on modern vessels.

RIGHT-LAID ROPE — Rope in which the strands are twisted to the right as the observer looks along a length of rope.

RIVER, OR SNUBBING, LINE — A group of wires, chains, and shackles used to control the course of a vessel immediately after the launching.

ROLLER CHOCK — (See Chock, roller).

ROPE — The product resulting from twisting a fibrous material, such as Manila, hemp, flax, cotton, cord, etc., into yarns or threads, which in turn are twisted into strands and several of these laid up together. Fiber rope is designated as to size by its circumference. Wire rope is made of iron, steel, or bronze wires twisted together like yarns to form strands, which in turn are laid up to form a rope. Wire rope is designated as to size by its diameter.

ROPE, CABLE-LAID — A term that was formerly applied exclusively to a rope consisting of nine strands, being made by laying three plain ropes together left-handed; now used to denote three (sometimes four) plain-laid, three-stranded ropes twisted together in the oposite direction to the twists in the several ropes. It is also known as hawser-laid and water-laid rope.

ROPE, HAWSER — A term applied to warping and towing lines.

ROPE, HEART — When a fiber rope has a heart it consists of a small, pliable rope the diameter of which is about one-third that of the strands. In a wire rope the heart may consist of a tarred hemp rope where pliability is the chief consideration and a wire heart where strength is more important.

ROPE, HEMP — A rope made from the fiber of the hemp plant. As in Manila rope, the fibers are made into yarn, the yarn into strands, and three or more strands twisted up to form rope.

Hemp rope where exposed requires tarring; otherwise it decays rapidly. Hemp rope is used principally for boltropes and standing rigging.

ROPE, MANILA — A rope made from fibers of Manila which are obtained from the wild banana plant growing in the Philippines. The fibers are made into yarn, the yarn into strands, and three or more strands twisted up form a rope. Manila rope is usually three-stranded up to 3″ in circumference; above that diameter it is four-stranded and has a heart center. This rope is more desirable for hawsers and running gear than hemp because it is lighter and more pliable and does not require tarring for preservation. Manila rope is stronger than tarred hemp rope.

ROPE, MARLINE — Hemp fiber loosely twisted and tarred. It is also called marline and hambroline.

ROPE, PARCELING — This operation consists of wrapping straps of canvas around the rope with the upper edges overlapping like shingles. For wire rope the strips should be coated with red lead and linseed oil; for fiber rope they should be tarred. The rope is usually wormed if parceled.

ROPE, PLAIN-LAID — A term that was formerly applied exclusively to the three-stranded, right-handed rope, but the term is now applied commercially to three-, four-, or six-stranded rope laid up in the contrary direction to the twist in the strands.

ROPE, PLOW-STEEL — A rope made from plow-steel wires. It is very strong and durable and is used for running gear. When it is designed for working over sheaves, it should not be galvanized.

ROPE, RIGHT-LAID — Rope in which the strands are twisted to the right as the observer looks along a length of rope.

ROPE, SEIZING — A method of making a joint between two ropes by bending with marline or spun yarn. There are three kinds of seizing, viz.: round seizing, where two layers of marline are used; flat seizing, where one layer of marline is used; throat seizing, where the parts of the rope or ropes cross.

ROPE, SERVING — Consists of wrapping a complete layer of marline or cord around a rope to protect it from chafing. The rope is usually wormed and parceled before serving.

ROPE, SISAL — The fiber for sisal rope is procured from a plant grown in the state of Yucatan, Mexico and near Key West, Fla. Its tensile strength is not more than three-quarters that of Manila fibers. Unlike Manila, sisal is stiff and harsh and deteriorates rapidly when exposed to the elements.

ROPE, SPLICING — A method of making a rope joint by braiding the strands. A splice in wire rope is relatively from 10 to 15 per cent weaker than a corresponding splice in fiber rope.

ROPE, SPUN YARN — Hemp fiber loosely twisted and tarred. It is also called marline and hambroline.

ROPE STRAND — Rope yarns twisted up, usually in a left-handed direction.

ROPE, WHITE — A term applied to untarred hemp rope. It is used for log and lead lines. The white rope is stronger than Manila.

ROPE, MARLINE-CLAD WIRE — A wire rope in which each strand is served with tarred marline before being twisted about the core.

ROPE, WORMING — Filling in the valleys between the strands of rope with marline. The marline should run with the lay of the rope.

ROPE, YARN — This consists of Manila or hemp fiber usually twisted up in a right-handed direction.

ROUNDLINE — A three-stranded, right-handed tarred hemp small stuff, used for seizings, service, etc.

RUDDER — A flat structure of wood or metal attached upright to the sternpost (or, in single-screw vessels, to the rudderpost of a vessel by hinges, or pintles and gudgeons) so that it can be turned, as by a tiller, causing the head of the vessel to turn in the same direction because of the resistance offered to the water by the rudder.

RUDDER PENDANTS — A term applied to a pair of chains or ropes attached by a shackle to a hole bored through the upper after end of the rudder frame (or to a monkey tail) for the purpose of providing temporary steering gear.

RUDDERPOST — The after post of the stern frame. The vertical post supports the rudder and is also called the sternpost.

RUDDERSTOCK — The shank of the rudder which extends through the shell up to the steering engine.

RUDDER STOP — A lug to limit the swing of the rudder.

RUNNER — A length of rope made fast at one end and rove through a single movable block, i.e., a single whip.

S

SAFETY BELT — A belt for use of riggers when climbing a pole or boom.

SAILMAKER'S WHIPPING — A seizing on the end of a rope made with a palm needle and waxed sail twine.

SAIL NEEDLE — A strong needle with a large eye; used by sailmakers in sewing canvas.

SEIZE — To secure one rope to another, two or more parts of the same rope to itself, or fittings of any kind to a rope (or other object) by binding with any small stuff.

SEIZING IRON — A round bar ½″ to ⅝″ in diameter and 18 inches long. Some seizing irons are made in the shape of a T. They are used when serving with wire over the parceling of a splice. They are also used for making wire throat seizings.

SEIZING STUFF — A tarred hemp, right-handed, three-stranded small stuff of two, three, or four yarns to the strand. It is heavier and stronger than houseline or roundline, being made by machinery and finished similar to the larger sized ropes. Seizing stuff is also made in galvanized annealed steel wire, six wires around a wire center, varying from 1/16 inch to ¼ inch in diameter.

SERVE — To wrap any small stuff tightly around a rope which has been previously wormed and parceled. Very small ropes are not wormed.

SERVICE — The covering of small stuff applied to a rope as a protection against the weather.

SERVING BOARD — A wooden tool used for winding a serving tight over a splice. It is used like a serving mallet.

SERVING MALLET — A mallet-shaped tool used when serving a rope with small stuff, marline, or the like.

SERVING STUFF — The various materials used in serving ropes, such as spun yarn, rope yarn, marline, houseline and roundline. Where great neatness is not essential, spun yarn is generally used; but marline, houseline, and roundline are used for neater work, since they are laid up more smoothly and made of superior material.

SHACKLE — A U-shaped link the end of which is closed by a removable pin or bolt. Shackles are used principally to connect the shots of chain cables, the blocks of davit heads, and other equipment where severe stress is applied, such as securing rigging to mast bands and deck connections.

SHAFT DOLLY — An arrangement of a number of heavy timbers with a cradle top to facilitate rolling heavy line shafting into place.

SHAFTING — Any type of shafting that is a part of the propulsion system of the ship or machinery, such as crank, thrust, line, or tail type.

SHACKLE BOLT — The bolt that passes through both eyes of a shackle and completes the link.

SHACKLE-BOLT PIN — A metal (or rarely, wood) pin used to secure a shackle bolt.

SHEAVE — A wood or metal disk having a groove around its cylindrical surface to accommodate a rope or chain which runs in the groove as the sheave turns on an axis.

SHIPFITTER — A mechanic who lays out shapes, marks the locations of rivet holes or openings, and indicates bevels on hull plates and other members by means of templates plotted according to dimensions secured either directly from the ship or from blueprints or mold loft. This work of the shipfitter insures that the various members fashioned according to his templates will fit satisfactorily into their places in the ship's structure.

SHORE — A temporary brace or prop.

SHORT SPLICE — A splice made where the rope is not required to render through a block and where an increased diameter is not objectionable, as in straps, slings, pendants, etc.

SHOT OF ANCHOR CHAIN — 15 fathoms, or 90 feet.

SHOT OF CABLE — 15 fathoms, or 90 feet.

SHROUD — A principal member of the standing rigging, consisting of hemp or wire ropes which extend from a mast to the side of the ship to the rim of a deck to afford lateral support for the mast.

SISTER HOOKS — Two half hooks which when placed one on top of the other form one full closed hook. These hooks should be moused at the neck to prevent their opening.

SLIDING WAY — That part of the launching way which moves with the ship when it is launched.

SLING — A length of chain or rope employed in handling weights with a crane or davit.

SMALL STUFF — Small rope or yarn used for parceling a rope.

SMOKESTACK — A metal chimney or passage through which the smoke and gases are led from the uptakes to the open air, after being exhausted from boilers, engines, or generators.

SNATCH BLOCK — See Block, Snatch.

SOCKET — A fitting attached to the end of a wire rope to secure and keep the wire strands in place.

SOUNDING LINE — The fine piano wire or wire rope used with a sounding machine; a log line.

SOUNDING MACHINE — A machine which has almost wholly superseded the antiquated and clumsy deep-sea lead. It is designed to ascertain the depth of water up to 100 fathoms accurately and quickly while the ship is moving at rather high speeds (16 or 17 knots).

SPANISH WINDLASS — A makeshift purchase consisting of a rope, a post or roller, and a lever.

SPAR — A long, round member, such as a mast or a boom; part of the rigging.

SPLASHBOARD — A board or plate frame used to hang on the side of a ship to prevent water's splashing on the dock.

SPLICE — A method of uniting two ropes by first unlaying, then interweaving and tucking, the strands.

SPLICER'S VISE — A vise used by riggers to hold in place the wire that is being spliced.

SPOOLING — The process of winding rope on a drum.

SPREADERS — Pieces of wood used to spread the slings over a load that is being lifted and so keep the slings from chafing the load.

SPRING LAY — A trade name for rope that combines the definite qualities of strength and durability found in wire ropes with the less tangible advantages of flexibility and easy handling found in Manila ropes.

SPRING LINE — A hawser run out from any part of a ship to a point on shore, as a dock, to prevent the ship's going ahead or astern.

SPUN YARN — A rough two-, three-, or four-yarn, left-handed small stuff, made from long tow or old rope yarns loosely twisted together.

SQUARE KNOT — See Knot, Square.

STAGING — Planks or scaffolding from which shipbuilders work on the sides or under the decks of a ship.

STANDING RIGGING — Rigging that is permanently secured to sustain the masts and fixed spars, such as shrouds, stays, bobstays, martingales, mast pendants, etc.

STARBOARD — The right-hand side of a ship, as the observer looks forward from aft.

STAY — A guy line.

STEP — To set in place (as applied to a mast); also, a socket for the end of a mast; a support for the fixed or "hinged" end of a boom.

STEP, MAST — See Mast Step.

STERN — The after or rear end of the ship.

STERN FRAME — A large casting or forging attached to the after end of the hull to form the ship's stern. It includes rudderpost, propeller post, and aperture for the propeller.

STERN TUBE — A long bushing or bearing through the stern to support the end of the propeller shaft.

STOPPER — A Manila rope stopper is a short length of Manila rope (8 to 12 feet long) with an eye spliced in one end and a whipping on the other. It is used to tie off a mooring hawser or hauling part of a rope while the end is being made fast to the bit, post, or cleat.

STOPPER, CHAIN — See Chain Stopper.

STOW — To pack away, to lash in place, or to secure in position otherwise for sea voyage.

STOWAGE — A support or fastening for any gear, as an anchor stowage or a boat stowage.

STRAND (of a rope) — An element of a rope, consisting of a fiber rope of a number of rope yarns twisted together; in a wire rope, a primary assemblage of wires.

STRAP — An endless rope or wire used in lifting loads or for handling material.

STRONGBACK — A bar for locking cargo port doors and watertight scuttles; a bar for receiving wooden hatch covers on cargo ships. It also prevents the cargo hatch coaming's being crushed in a rough sea. The cargo hatches are placed on top of these strongbacks which are also covered with 3 or 4 canvas tarpaulins.

STRUT — A support for a propeller tail shaft (used on ships with more than one propeller).

SWALLOW — The space or opening through which a rope passes between the rim of the sheave and the frame of the block.

SWIVEL — A special link constructed in two parts which revolve on each other. It is used to prevent fouling due to turns in the chains.

T

TACKLE — Any combination of ropes and blocks that multiplies power.

TAIL SHAFT — A short section of the propeller shaft extending through the stern tube and carrying the propeller.

TAG LINE — A length of rope ranging from 18 thread to 3″ Manila which is secured to an object that is being hoisted to keep it from turning.

TALLOW, LAUNCHING — See Launching Tallow.

TAPELINE (Steel) — A measuring line made of steel. Riggers generally use a 100-foot tapeline.

TARPAULIN — A waterproof canvas used for covering hatches; a temporary covering for material, machinery, or electrical equipment.

TAUT — The condition of a rope, wire, or chain when under sufficient tension to cause it to assume a straight line or prevent sagging to an appreciable extent.

TELEGRAPH — An apparatus, either mechanical or electrical, for transmitting orders from a ship's bridge to the engine room.

TEMPLATE — A mold or pattern made to the exact size of a piece of work that is to be laid out or formed. Such information as the position of rivet holes, size of laps, etc., is indicated on the template.

TENSILE STRENGTH — The measure of a material's ability to withstand a tensile, or pulling, stress without rupture.

THIMBLE — A circular, oval, or heart-shaped iron fitting, the outer surface of which is concave in order that it may be held in place when worked into the corner of a sail (as a cringle) or into the bight of a rope.

THREAD — The spiral part of a screw.

TILLER WIRE — Wire rope which is made fast to a rudder stock and to the steering-wheel drum which steers the ship. It consists of 6 strands, 37 or 42 wires to the strand, and gives great flexibility.

TOLERANCE — The amount that is permissible over or under a specified size.

TOPPING LIFT — A rope or chain extending from the head of a boom or gaff to a mast or to the vessel's structure for the purpose of supporting the weight and permitting the boom or gaff end to be raised or lowered.

TOPPING-LIFT TACKLE — Tackle between the boom and the masthead. It is used for lowering and raising the boom.

TON — 2000 lbs.

TREBLE PURCHASE — A purchase in which two treble blocks are used.

TRIAL TRIP — An extended maneuver of the ship after completion. All the operating equipment is checked for performance and overload. The engines must develop the stipulated horsepower. Standardization of ship speeds are established according to increase or decrease of shaft revolutions per minute. The ship must make a certain speed. Windlass and deck machinery must be able to lift and haul specified loads under test conditions, and all other equipment must be proved satisfactory to the new owners and the classification societies (American Bureau, Lloyds' Register, and Coast Guard S. B. Inspection).

TRIM — The position of a vessel as to her forward, after, and athwartship immersion in the water.

TRUCK — The cap or ball at the extreme top of the topmast or topgallant mast.

TRUNDLE HEAD — The circular portion of the capstan head designed to take the ends of the capstan bars for turning.

TUG; TUGBOAT — A vessel equipped with heavy-duty engines and machinery, and used for towing various types of floating craft.

TURNBUCKLE — A device for connecting two parts of a bar, rod, or rope together with an adjustable tension.

TRESTLE — A wood or steel arrangement in the shape of an A for supporting staging or other light objects.

TWINE — Small, cotton or flax cord, or thread, used by sailmakers in working on canvas.

TWOFOLD PURCHASE — A purchase in which two double blocks are used.

W

WATCHES — Nautical divisions of time, usually four hours each, for standing watch or being on deck ready for duty.

WAYS — Timbers on which a ship is built and from which it is launched into the water. (See launching).

WEDGES — V-shaped wood or metal pieces used for driving up or separating work.

WEIGH — To take the weight of the anchor on the chain; to hoist the anchor.

WHEEL — A nickname for the propeller; steering gear control.

WHIP — This term is loosely applied to any tackle used for hoisting light weights and serves to designate the use to which a tackle is put rather than the method of reeving the tackle. Any single hauling rope.

WHIPPING — Turns of twine or small stuff wound around the end of a rope to prevent its unlaying.

WINCH — A small hoisting engine used in pulling lines or handling cargo.

WINCH HEAD — A small auxiliary drum usually fitted on one or both ends of a winch.

WINDLASS, SPANISH — See Spanish Windlass.

WIRE ROPE — See Rope, Wire.

WORMING — Filling the contlines of a rope with tarred small stuff preparatory to parceling and serving.

WRENCH — A tool for twisting or turning bolts or nuts.

Y

YARN (or thread) — A number of fibers twisted together. This twist is usually right-hand, but can be left-hand if the use of the rope requires.

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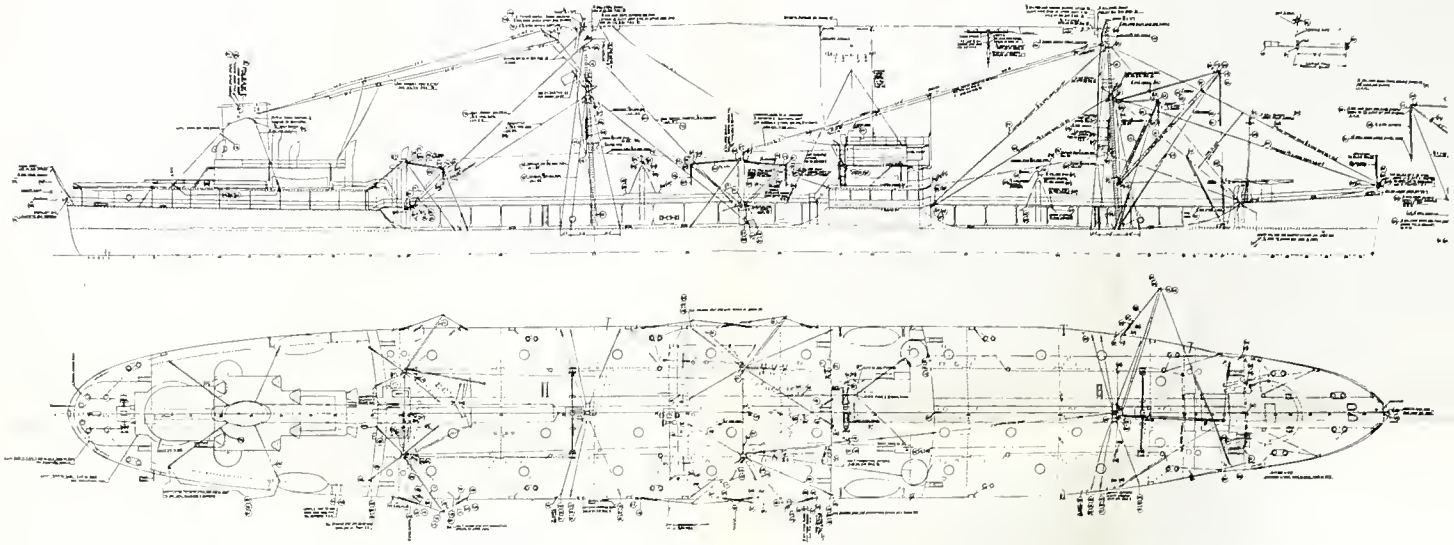

BILL OF MATERIAL (FOR ONE SHIP)

14 1 Main Topmast, 1 Fore topmast
16 to Fwd Boom Foremast
17 20 Iron Bound Bolts and washers for K.P. BATT K.P.
33 Feet (abt.) 2 Fwd End of Mid. K.P.
81 Open Socket for 1½" D Wire Rope
82 Closed Socket for 1.5 3" D Wire Rope
83 ⅞" Pipe Jaw & Jaw Turnbuckle for 1¼" Close Jaw
84 Open Socket for 1¼" Std. Wire Rope
85 Closed Socket for 1¼" D Wire Rope
86 1½" Pipe Jaw & Jaw Turnbuckle for 1½" Close Jaw
87 Open Socket for ⅝" D Wire Rope
88 Closed Socket for ⅝" D Wire Rope
89 ⅝" Pipe Jaw & Jaw Turnbuckle for 1⅛" Close Jaw
90 Boom Cap 2 — For Pr. 104 — For Pr. 17, Boomie
91 Boom Band Over for Each Pr. 18 Boomie
92 Gooseneck 2 — for Pr. 104 for Pr. 172 — For Pr. 18
93 Boom Cap 3" — Dia. 1 3/4" Pl. 1½"d

94 Boom Band One for Each Pr. 16 F.M. Boom
95 Anchor Light Hanger
96 Navy Light Tail
97 2" Cleat 4½" Dia. Rod Bent to Shape)
98 12" Cleat (Welds)
99 14" Cleat Omit Bolt Holes (Welds)
100 Pad For 12in Boom
101 Shackle Snatch Block
102 Cleat Pl. 6½" x 3" x 2½" Th (Welds)
103 Chain Pl. 6½" x 4½" x 1½" Th
104 Chain Pl. 6½" x 5" x 1¼" Th
105 Chain Pl. 6⅞ 10" x 6½" x 1½" Th
106 6" x 6" x 15.3" Pl.
107 Double Stay Pad
108 Forward Nr. Shank (Welds)
109 Forward Nr Shank
110 1 ¼" Anchor Shackle ⅞" Dia. Pin 1½" Ins 6½"d

111 ½" Thimble for 3½" Gov Mast, Rope
112 ⅜" Thimble for ⅝" Dia. Wire Rope Served
113 1⅝" Anchor Shackle 1½" D Pin 2¼" Clear Brt. Jaws
114 1" Anchor Shackle 1¼" D. Pin 1-11/16" Clear Brt. Jaws
115 Closed Socket for ⅝" D Wire Rope
117 Stanchion Bkt
132 Topping Lift #2 Foremast Boomie)
133 Fall #2 Foremast Boomie
134 Topping Lift 1 6 Midship Kingbomi)
135 Topping Lift 12 Over Kingpost)
136 Fall 6 Mid. K. Posts
137 Fall 2 Aft K. Posts
138 Yangs Foremast Boomie
139 Yangs Midship K.P. Boomie
140 Yangs Aft K.P. Boomie
141 Gasoline 3 Foremast, 1 Mainmast
142 Stack Falls

143 Anchor Light Halyard Fwd
144 Windmill Pendant
145 Windmill Halyard
146 Tool le at M.M. 4 F.M. For Windmill Span
147 Windmill Sheet 12 Thd
148 Ensign Staff Halyard Aft
149 Anchor Light Halyard Aft
150 Truck Halyard Foremast & M.M.
151 Jackstaff Halyard
161 Footstay — Foremast
162 Shrouds Fwd — Foremast
163 Shrouds Aft — Foremast
164 Backstay
165 Mainstay — Mainmast
166 Shrouds Fwd — Mainmast
167 Shrouds Aft — Mainmast
168 Backstay — Mainmast

169 Fore Topmast Stay (Foremast)
170 Main Topmast Backstay Mainmast
171 Topmast Backstay Foremast
172 Main Topmast Forestay Mainmast
173 Spankmast Fwd Guys
174 Spankmast Aft Guys
175 Topmast Stay — Mainmast
176 Topmast Stay — Foremast
177 Mast Windmill Pendants Support Abt. 7'-0"
178 Windmill Span 1 F. 1-5, Fwd
179 Windmill Span 1 F. 1-5, Aft
180 Pendant for Yangs 2 Foremast Boom
181 Pendant for Yangs 4 Midship Boome
182 Pendant for Yangs 2 Aft Boome
183 Cross Stay Midship K.P.
184 Cross Stay Aft K.P.
185 Stays After K.P. Aft I.R.

186 Stays After K.P. Aft O.R.
187 Stays After K.P. Fwd I.R.
188 Stays After K.P. Fwd O.R.
189 Stays Midship K.P. Aft I.R.
190 Stays Midship K.P. Aft O.R.
191 Stays Midship K.P. Fwd I.R. Mid.
192 Stays Midship K.P. Fwd I.R. Fwd
193 Stays Midship Fwd O.R.
194 Stays Midship K.P. Fwd I.R. Mid.
195 Stays Midship Fwd O.R.
196 Stays Midship K.P. Fwd I.R. Fwd
197 Stays Midship Fwd O.R.
198 12" Dbl. Block Heavy Wide Mortise
199 12" Sgl. Block Heavy Wide Mortise
200 10" Sgl. Block Heavy Wide Mortise
201 10" Dbl. Block Heavy Wide Mortise
202 12" Dbl. Block Heavy Wide Mortise
203 12" sgl. Block 4 Sheaves)
204 10" Dbl. Block Heavy Wide Mortise
205 10" Dbl. Block Heavy Wide Mortise
206 10" Sgl. Block 4 Sheaves)
207 10" Dbl. Block Heavy Wide Mortise
208 10" Dbl. Block Heavy Wide Mortise
209 10" Sgl. Block Heavy Wide Mortise

210 12" Dbl. Block Heavy Wide Mortise
211 12" Dbl. Block Heavy Wide Mortise
212 12" Sgl. Block Heavy Wide Mortise
213 8" Sgl. Block Heavy Wide Mortise
214 8" Sgl. Block Regular Mortise
215 6" Sgl. Block Regular Mortise
216 6" Sgl. Block Regular Mortise
217 7" Dbl. Block Regular Mortise
218 7" Sgl. Block Regular Mortise
219 6" Sgl. Block Regular Mortise
220 3" Sgl. Block Regular Mortise
221 3" Sgl. Block Regular Mortise
222 4" Sgl. Block Regular Mortise
223 12" Sgl. Block Regular Mortise